"GREEDY FOR FACTS": CHARLES DARWIN'S INFORMATION NEEDS AND BEHAVIORS

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I am greedy

for facts: —

GREEDY FOR FACTS

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Aptly describing himself as “greedy for facts” and exercising “industry in observing and collecting facts”, Charles Darwin passionately sought and assiduously organized, managed, communicated, and used information throughout his life. From a 21st-century information age perspective, Darwin can be seen as a pre-Melvil Dewey, multidisciplinary, Victorian era proto-information manager, whose skillfully-employed information behaviors were fundamental to realizing his seminal *Origin of Species* (1859) and in influencing his life-long scientific development. A large body of research about Darwin exists but little has been written in the library and information science (LIS) field regarding Darwin and his pivotal relationship with information. Human information behavior (HIB) is an emerging LIS subfield, which has principally studied the information needs and information seeking behaviors of modern era human beings. Cambridge University is the foremost provider of print and electronic access to more than 14,000 transcribed and edited extant letters written by and to Darwin. Using historical case study methodology, this dissertation applies an HIB-oriented approach to investigate and inventory Darwin’s information needs and behaviors through analysis of his surviving correspondence and other primary and secondary Darwin-related scholarly sources. A general framework is developed, designating five interrelated, broad context information behavior (BCIB) classification categories for conceptualizing Darwin's information behavior roles: as information seeker, organizer, manager, communicator, and user. In the vein of Ellis et al.'s (1993) study designating eight information seeking behaviors exhibited by contemporary British scientists, this dissertation utilizes grounded theory to derive and explain more than fifty descriptive information behaviors (DIBs) exhibited by Darwin. DIBs are conceptual constructs which are used to specify and describe, via words and examples from Darwin's correspondence and writings, the relevant characteristics and nuances of his diverse information behaviors. A case study examines and explicates the crucial ways in which Darwin's information behaviors proved instrumental in preserving priority for his evolutionary ideas during a crisis period involving rival evolutionary theorist Alfred Russel Wallace in 1858. An information-related timeline of Darwin's life, graphic models, and digital photographs illustrating his information behaviors are presented. Limitations of the study and areas for further research are also discussed.

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I. INTRODUCTION

“I am greedy for facts.” These five words—written by Charles Darwin to Queen Victoria’s surgeon, James Paget, in an 1867 letter, of which only this z-shaped fragment survives—succinctly encapsulate a defining theme of his life: passionate desire for information. Like an enamored but internally conflicted Jane Austen-esque protagonist of the Victorian romance novels into which he sometimes escaped, Darwin’s love affair with information was both exhilarating and tormenting. It was also a relationship in which Darwin’s complex, long-term plans and aspirations for his information pursuits were habitually hidden from most of the people around him and the world at large, but for his closest confidantes and trusted allies.

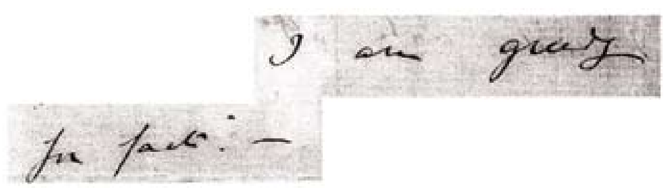

Figure 1. Extant fragment of letter written by Charles Darwin to James Paget, circa 1867. Reproduced by permission of the American Philosophical Society

Only the threat of a rival's preemption of his priority impelled him to selectively divulge his ideas to a London scientific society in 1858, hastening the writing and eventual public debut of his evolutionary theory by natural selection. Those efforts culminated in late 1859 with the publication of *Origin of Species*.

Origin was a pioneering, paradigm-challenging theory, contained and explained within a book that was underpinned by more than two decades of collected, arranged, and assembled information, much of it attained during Darwin's life-changing tenure as ship's naturalist on the epic 1831-1836 *Beagle* voyage. From a constructionist standpoint, *Origin* represents a synthesis of information spanning millions of years and Darwin's present-day reasoning. At a socio-cultural level, it is, at its simplest, a well-crafted, engaging read: a daring, iconoclastic book that was ultimately realized through Darwin's systematically gathered and described collections, meticulous organization, skillful, prioritizing management, shrewd communication, and selective use of his seemingly boundless cache of accumulated information. Holistically, Darwin's *Origin* personifies humanity's centuries-long collective sense-making attempt to connect ostensibly random, unrelated dots of information into an explanatory picture. Fundamentally, it is all about information. Arguably as well, *Origin* is one of the most momentous information feats in scientific history, achieved by a man who was intensely proprietary about information and highly skilled in wielding and working with it. But, although *Origin*'s essence is the presentation of carefully compiled and reasoned information, surprisingly, Darwin is not typically associated mentally with "information". Moreover, he has neither been widely perceived as an information figure nor treated as particularly relevant to library and information science (LIS) history and research, aside from some interest in his classification efforts. To the contrary, this dissertation asserts, Darwin can and should be viewed more broadly, within LIS and society in general, as a multi-faceted, innovative, early information practitioner. Indeed, from a 21st-century information age perspective, Darwin can be seen as a pre-Melvil Dewey, multidisciplinary, Victorian era proto-information manager, whose life and work were inextricably entangled with information.

A large body of research pertaining to Charles Darwin exists in many scientific fields, such as the natural sciences and the history of science and philosophy. A number of LIS studies have investigated the information behaviors of scientists in general. Spink and Currier (2006b) conducted an exploratory study of the information behaviors of eight historical persons, including several scientists and a preliminary inspection of Charles Darwin's autobiography. Ellis et al. (1993) identified eight categories to describe the information seeking activities of a group of British social scientists, chemists, and physicists. However, little has been written in the LIS field regarding Darwin's substantial information-relevant activities and works. Drawing upon the major authoritative and scholarly primary and secondary Darwin source materials, this study posits that an array of information-related activities engaged in by Darwin—such as collecting, observing, recording, corresponding, face-to-face networking, evaluating, arranging, claim-staking, and dispersing, among several dozen others—were fundamental to his scientific development and achievements.

Hence, in the vein of studies such as Spink and Currier (2006b) and Ellis et al. (1993), a significant goal of this dissertation is to examine and identify Darwin's information needs and behaviors. The overarching objective of this historical case study is to inventory, describe, explain, and model Darwin's information process behaviors. In Appendix A this dissertation provides a timeline of significant events in Darwin's 1809-1882 life that incorporates information-related activities, which are discussed in various sections of this research.

Studying historical subjects like Darwin from the "dead past" presents distinct research challenges: chiefly, the validity and use of reliable, pertinent data sources. Fortunately, a substantial corpus of Darwin-related writings and materials is available for present-day researchers to study. Darwin was a diligent writer and keeper of correspondence, and more than 14,000 letters by and to him survive. Cambridge University holds more original Darwin archival materials, including correspondence, than anywhere in the world and has been at the vanguard in making these resources accessible for study. To that end, Cambridge is progressing with an ambitious decades-long research-facilitating project of transcribing, editing, and publishing all extant Darwin correspondence encompassing his 1809-1882 lifespan. Thus far, Cambridge University Press has recently published volume 15: 1867 of this projected 30-volume set entitled The Correspondence of Charles Darwin (CCD). Recently as well, another simultaneously ongoing project, Cambridge's Darwin Correspondence Online Database (DCOD), provides free Internet-based electronic access to Darwin's correspondence, much of it searchable by keyword and accessible in full-text. Another related Cambridge project, The Complete Work of Charles Darwin Online (CWCDO), was inaugurated in late 2006 and offers full-text and keyword access to all known Darwin-related works. This dissertation principally utilized the CCD, CDOD, and CWCDO print and electronic resources to find, collect, and analyze data pertaining to Darwin's information needs and behaviors.

As a research tool, the extant letters written by and to Darwin are singularly useful for investigating and shedding light on his thoughts and actions. Some letters, such as those written to his most trusted peers and confidantes, geologist Charles Lyell and botanist Joseph Dalton Hooker, afford candid, relevant insights into Darwin's information-related activities, as well as his masked insecurities and fears, his uncensored hopes and desires. Other letters are useful for showing a Darwin who is more tightlipped about his ultimate aims. These letters also serve to illuminate the more shrewdly calculating chess player-like steps by which he often sought, analyzed, managed, communicated, and used information. An important observation that emerges from reading and scrutinizing Darwin's letters longitudinally is that many of his thoughts and actions were related to and focused upon information, or as he interchangeably referred to information—facts. Specifically, Darwin's letters highlight his inventive efforts and persistent dedication (at times approaching obsession) to locating, making sense of, and utilizing facts and information. The facts and information sought by Darwin constituted a variety of items on a continuum: concentrating upon (1) print sources—scholarly articles, borrowed books, observations on animal breeding and botanical cultivation, experiment results, and field experiences reported by Darwin's many correspondents or communicated through face-to-face networking—and (2) physical specimens of a geological, botanical, and zoological nature, e.g. rocks, plant seeds, and animal skulls and skins.

Correspondence as an activity was a vital means for seeking and acquiring the information that Darwin needed in order to realize his larger scientific objectives of publication and dissemination of his studies' findings and theories. To promote the achievement of those long-range objectives, Darwin gradually created and nurtured an extensive information network of globally-situated correspondents. Cultivation of his network was facilitated by the British Empire's expanding global footprint as well as the numerous far-flung colonies of the other Western powers, thereby stimulating a profusion of world-spanning Victorian era scientific traveler-explorers. Through this global network, Darwin harvested, sorted, and capitalized upon facts and information provided to him by scientists from "each chief quarter of the world". Long-term reflective thinking about such information, which was (1) attained from myriad local and distant human and print sources, and (2) combined and leveraged with Darwin's own findings, voluminous notes and annotated references, analyses, and reasoning, was integral to his writings and success as a published author and theorist.

Indeed, perhaps most consequentially—and fittingly from an evolutionary theory standpoint—Darwin's conscientious information manager behaviors gave him a competitive advantage over his scientific rivals. Underscoring this crucial edge is the illustrative example of the 1858 contest for scientific priority between Darwin and an unexpected rival evolutionary theorist named Alfred Russel Wallace. In a fortnight's-long struggle for evolutionary theory's exclusive "bragging rights", initially plotted behind-the-scenes by Darwin and his allies and then strategically and climactically waged on July 1, 1858 by those same Darwin proxies within a venerable London scientific society's oak-paneled meeting room, a host of Darwin's varied but interconnected information behaviors—observing, reflecting, understanding, recording and note-taking, copying, lending, corresponding, claim-staking, filing and storing, retrieving, transmitting, delegating, presenting, and publishing of the information and documentation under his management and control—would prove both instrumental and decisive. A case study examining this critically important period vis-à-vis Darwin and his information behaviors will be discussed in detail in the Darwin/Wallace case study.

Author's note: Darwin called the home where he resided for the second half of his life from 1842 - 1882, Down House. The home's name was taken from Down Village, Kent, England, where the house was and still is located. Down was the spelling of the village when Darwin and his family first moved there. However, the village added an "e" to its name in the mid-1800's; use of the new spelling, Downe, has been the convention since that time. The Darwin family, though, continued to use the old spelling of Down to refer to their home, which can sometimes cause uncertainty when referring to or discussing Down House and Downe Village. Desmond and Moore (1991) explain that, "The village changed its spelling to Down in mid-century, to avoid confusing with County Down in Ireland. Down House retained the old spelling" (p. 395). In this dissertation, "Down" is always used in conjunction with Down House. Some cited quotations contain the word "Downe", which refers to Downe Village and not Darwin's home.

II. PROBLEM

A. DEFINITION OF TERMS

A number of definitions and concepts which are important to this dissertation are defined below:

1. Information

Many definitions of 'information' exist. Sifting through an assortment of information definitions, Case (2002) argues for "treating information as a primitive concept that is so basic to human understanding that it does not require a tight definition" (p. 63). Thus, Case adopts the definition "any difference that makes a difference", with an added constructivist requirement that a conscious human mind "must be engaged at some point for information to be said to exist" (pp. 60, 63). This constructivist 'conscious human mind' conceptualization of information will be used in this study. The dissertation will employ a broadly constructed but more specific definition of information as "organic and inorganic stimuli, data, facts, and/or knowledge actively or passively making contact with a human receiver."

2. Facts

Darwin interchangeably used the term 'facts' and 'information'. Hence, for this dissertation 'facts' will be used and understood as a synonym of 'information'.

3. Knowledge

Information will be deemed to include and encompass knowledge as a component of information. Knowledge in this study, therefore, will be viewed as a type of information and is included within the dissertation's working definition of information, defined above.

4. Human information behavior

This dissertation's area of research concentration is the field of human information behavior (HIB). HIB is a subfield of library and information science (LIS). Wilson (1999) explains information behavior as "those activities a person may engage in when identifying his or her own needs for information, searching for such information in any way, and using or transferring that information." Wilson (2000) also provides a definition of information behavior as "the totality of human behavior in relation to sources and channels of information including both active and passive information seeking, and information use." Pettigrew et al. (2001) define information behavior as "how people need, seek, give, and use information in different contexts", providing another conceptualization.

These three definitions of human information behavior guide this study of Darwin's information behaviors. The dissertation utilizes an amalgamated definition of human information behavior informed by the above definitions: "how human beings actively and passively need, seek, organize, manage, communicate, and use information in diverse contexts."

5. Information needs

Similar to efforts focused on deriving a universal definition of 'information', developing an explanation for how information influences human behavior is equally challenging (Case, 2002). Information needs are an important aspect of human information behavior, influencing the ways in which humans behave vis-à-vis information. Case (2002) defines an information need as "a recognition that your knowledge is inadequate to satisfy a goal that you have." This study modifies and expands Case's definition and defines an information need as "an absence or insufficiency of stimuli, data, facts, or knowledge related to potential fulfillment of a known or consciously unacknowledged human goal."

6. Information behaviors

In addition to identifying Darwin's information needs, this dissertation also examines several broad, general categories of his information behaviors: information seeking, information organizing, information managing, information communicating, and information use.

a. Information seeking behavior Spink and Cole (2005) define *information seeking* as a subset of information behavior that includes the purposive seeking of information in relation to a goal. This dissertation restructures and expands Spink and Cole's conceptualization and defines *information seeking behavior* as "active and passive searching for, detecting and identification of, and/or acquiring of information, often connected to a known or yet-to-be-determined goal."

b. Information organizing behavior *Information organizing behavior* has been described as the process of analyzing and classifying materials into defined categories (Spink & Cole, 2005; Cole & Leide, 2006). However, information organizing has more dimensions than analysis and classification and does not necessarily have to include classifying. A more nuanced definition should incorporate the varied intents and objectives of information organizing, such as placing or preserving information and items in neat, required, accessible, convenient, and/or useful order. This dissertation defines *information organizing behavior* as "analyzing and assessing information for purposes of cataloging, classifying, arranging, filing, and/or retrieving, typically in connection with a known or yet-to-be-determined goal."

c. Information managing behavior *Information managing behavior* is "administering, influencing, controlling, and maintaining the use or exploitation of information, connected to a known or yet-to-be-determined goal."

d. Information communicating behavior *Information communicating behavior* is "transmission, reception, and/or exchange of oral and/or written information involving two or more persons."

e. Information use behavior *Information use behavior* involves incorporating information into an individual's existing knowledge base (Spink & Cole, 2005). This dissertation defines *information use behavior* as "incorporating, modifying, disseminating, or taking affirmative action with regard to acquired information, connected to a known or yet-to-be-determined goal."

7. Broad context information behaviors (BCIBs)

Broad context information behaviors (BCIBs) are general information behavior categories, which provide a conceptual framework and systematizing context within which related information behaviors can be grouped, situated, understood, and depicted within graphic models.

8. Descriptive information behaviors (DIBs)

Descriptive information behaviors (DIBs) are narrower human information behavior (HIB) classification categories than broad context information behaviors (BCIBs). DIBs serve as conceptual and graphic tools for specifying, via words and examples, the relevant characteristics of a person's information behaviors. DIBs radiate from at least one or more of the BCIB categories.

B. ABBREVIATIONS

The following frequently cited abbreviations are used in this dissertation:

1.	CD	Charles Darwin
2.	CCD	*The Correspondence of Charles Darwin*
3.	DCOD	Darwin Correspondence Online Database
4.	CWCDO	The Complete Work of Charles Darwin Online
5.	LIS	Library and information science
6.	IS	Information science
7.	HIB	Human information behavior
8.	BCIB(s)	Broad context information behavior(s)
9.	DIB(s)	Descriptive information behavior(s)

C. RATIONALE, SIGNIFICANCE, AND NEED

1. Principal HIB conceptual approaches

As stated earlier, this dissertation is situated within the human information behavior (HIB) subfield of LIS research. A number of conceptual approaches have been developed for examining human information behavior. These conceptual approaches include Wilson's (1999) *problem solving,* Savolainen's (1995) *everyday life information seeking (ELIS),* Dervin's (1992) *sense-making,* and Pirolli and Card's (1999) *information foraging.*

2. Evolutionary perspective for HIB

Spink and Currier (2006a; 2006b) assert that HIB and the conceptual approaches cited above have largely focused on contemporary study of human information behavior. With the objective of expanding HIB's focus from studying mainly post-1945 aspects of information behavior, a new evolutionary perspective and approach is emerging within the HIB field (Spink & Currier, 2006a). This evolutionary perspective has strong connections to the evolutionary approach that has developed in other scientific fields, such as evolutionary biology, evolutionary psychology, and cognitive archeology (Spink & Currier, 2006a). The chief aim of these fields is to investigate and explain how the human mind works from an evolutionary perspective (Barkow, Cosmides & Tooby, 1992; Mithen, 1996; Spink & Cole, 2005; Spink & Currier, 2006a). These researchers advocate an interdisciplinary perspective that draws on the methodology and knowledge of diverse fields in order to increase understanding of the human mind. Mithen (1996) supports this research philosophy with his contention that "almost all disciplines can contribute towards an understanding of the human mind" (p. 10). Researchers using an evolutionary perspective, like Mithen (1996), Tooby and Cosmides (1989), and others, emphasize the important scientific insights that research objectives like the mapping and identification of behaviors can yield toward enhancing such understanding.

Some LIS researchers are examining and utilizing the evolutionary approach as a means for studying and understanding human information behavior. Bates's (2005) "Information and Knowledge: An Evolutionary Framework for Information Science" summarizes the evolutionary perspective:

> Over the last several decades, researchers in biology, anthropology, and psychology have come together to study human behavior in a new way. That new framework is rooted in an understanding of evolution and its impact on the cognitive, linguistic, and social structures of human beings...These researchers have been working to integrate their disciplines' understandings of human beings in ways that promote a richer comprehension than any one perspective provides. This 'conceptual integration' (Cosmides, et al., 1992) in the human sciences is intended to relate and connect the knowledge among these disciplines, not reduce one field to another… [T]he evolutionary context enriches one's understanding and provides a possible foundation for building a scientifically-based conception of information that also harmonizes with several of the more social-science-based theories of information in our field. (p. 5).

Additionally, Spink and Currier (2006a) cite a significant strength of the interdisciplinary evolutionary perspective:

> [Barkow, Cosmides, and Tooby] emphasize the ability of conceptual integration to create anchor points which enable the

> bridging of gaps that one's own and other fields may not be able to span by themselves. Such conceptual integration, they assert, generates powerful knowledge growth because it enables researchers to use knowledge gained in other disciplines to solve problems in their own. (Barkow, Cosmides and Tooby, 1992.)

3. Expansion and evolution of HIB field

The evolutionary perspective can be seen as a significant broadening and evolution of the HIB field: from a field focused mainly on modern era human information behaviors and predominantly systems-centered research to one that encompasses all human information behaviors and emphasizes more human-centered studies. It offers a number of advantages and opportunities, as described by Spink and Currier (2006a):

> This approach will more fully contribute to the understanding of the evolution of human behavior in general and further integrate HIB research at a fundamental, theoretical level with the social sciences and humanities. It may also contribute to a more holistic understanding of the relationship between humans and information as well as the nexus among humankind, information and human evolution. (p. 16).

Spink and Currier (2006a) reference Mithen's (1996, p. 10) assertion that "[W]e can only ever understand the present by knowing the past" as a strong rationale for increasingly expanding the chronological scope of HIB studies to encompass persons from past eras as well as modern ones.

4. Models

One strategy for better understanding the past is to attempt to develop illustrative models. Models are important tools utilized by scientists for formulating questions or hypotheses about whether something will happen, i.e. causality, relationships between variables, and so forth (Krathwohl, 1998, p. 65). Models often are generated from scientific explanations or rationales founded on prior research (p. 70). Additionally, researchers often strive to link themes to each other via placement and depiction of such themes in a theoretical model (Miles & Huberman, 1994, pp. 134-137; Bernard, 2002, p. 469; Robson, 2002).

Few HIB-related models have been created, most likely because HIB is an emerging field. Models frequently are generated from theory-building and IS has tended to borrow theories from other fields, so model-building for IS and HIB is generally in a formative stage when compared with other social sciences. Spink and Currier (2006a) provide a preliminary chronological model of information behaviors, which will be discussed in the Literature Review section below. An important objective of this dissertation was to develop models that could describe and illustrate Darwin's information needs and behaviors. Several models, which were developed through this dissertation, will be presented and discussed below.

5. Analyzing autobiographical writings

Looking for evidence of a deceased person's information behaviors requires a different kind of research methodology than, for example, real-time, face-to-face interviews. One way to search for this kind of data is to analyze the surviving documentary evidence that was written by such people. To that end, Spink and Currier (2006b) in an exploratory study examined the autobiographies, diaries, journals, and personal letters written by eight noted persons from past eras. The study's objective was to identify instances in which these persons described their own information behaviors. Subjects included French Emperor and military leader Napoleon Bonaparte (1769-1821), and academics and scientists, like Charles Darwin (1809-1882), astronomer Cecilia Payne-Gaposchkin (1900-1979), and Sigmund Freud (1856-1939). Spink and Currier specifically identified examples in which the eight subjects described their own information seeking, information organizing, and information use behaviors. Regarding Darwin, the researchers provided the following examples of information organizing described by Darwin:

> I have bought many books and at the ends I make an index of all the facts that concern my work; or, if the book is not my own, write out a separate abstract, and of such abstracts I have a large drawer full. (Barlow, 1958, pp. 137-138).

> Before beginning on any subject I look to all the short indexes and make a general and classified index, and by taking the one or more proper portfolios I have all the information collected during my life ready to use. (Barlow, 1958, p. 138).

6. Significance of Darwin's information behaviors

As explained above, Spink and Currier's (2006b) study was exploratory in nature and the information behavior evidence from the eight subjects was gleaned from a sampling of these eight persons' writings. Consequently, the information behavior examples cited in the study do not represent either a more comprehensive or exhaustive inspection of all work by and/or involving the study subjects. For instance, with respect to Darwin's information behaviors, Spink and Currier (2006b) principally analyzed Darwin's (Barlow, 1958) autobiography. However, one weakness of this approach is that Darwin wrote his autobiography late in life. It was a quasi-folksy retrospective look back at the circumstances and key events of his life, composed more as family history for his children and descendants, as it were, than rigorous historical record. Most importantly, in terms of its use and reliability as a historical source, the autobiography discussed past events in his life that were not close in time to when they occurred. Hence, the events and dates recounted may be subject to errors of recollection and accuracy. In addition, relying exclusively on Darwin's autobiography to identify his information behaviors is potentially problematic and imposes a limitation on the study. As Browne (1995) writes in the first volume of her two-volume Darwin biography, "His autobiography was just as much an exercise in camouflage—a disguise—as it was a methodical laying out of the bare bones of his existence" (p. xii).

Fortunately with regard to Darwin, a much richer lode of Darwin-related materials is available for data mining, as cited and evinced in this dissertation. Much of those materials were kept and saved by Darwin himself. As Desmond and Moore (1991) relate, "Darwin was a hoarder; he destroyed precious little. Notebooks, old manuscripts, torn-out pages, annotated offprints, and letters were all salted away" (p. xix). In addition, other Darwin biographical sources support this as well. A particularly good example comes from Darwin's son Francis, who frequently assisted Darwin with his work. Francis Darwin's *The Life and Letters of Charles Darwin* (1898) offers a lengthy, but informative, detailed description of his father's information seeking, organizing, and managing activities:

> [Darwin] was methodical in his manner of reading books and pamphlets bearing on his own book. He had one shelf on which were piled up the books he had not yet read, and another to which they were transferred after having been read, and before being catalogued…Many a book was at once transferred to the other heap, either marked with a cypher at the end, to show that it contained no marked passages, or inscribed, perhaps, "not read," or "only skimmed." The books accumulated in the "read" heap until the shelves overflowed, and then, with much lamenting, a day was given up to the cataloguing…In each book, as he read it, he marked passages bearing on his work. In reading a book or pamphlet, &c., he made pencil lines at the side of the page, often adding short remarks, and at the end made a list of the pages marked. When it was to be catalogued and put away, the marked pages were looked at, and so a rough abstract of the book was made. This abstract would perhaps be written under three or four headings on different sheets, the facts being sorted out and added to the previously collected facts in the different subjects. He had other sets of abstracts arranged, not according to subject, but according to the periodicals from which they were taken. When collecting facts on a large scale, in earlier years, he used to read through, and make abstracts, in this way, of whole series of journals. In some of his early letters he speaks of filling several note-books [sic] with facts for his book on species; but it was certainly early that he adopted his plan of using portfolios, as described in the '*Recollections*'…The racks in which the portfolios were placed are shown in the illustration ... in the recess at the right-hand side of the [Down House study's] fireplace. My father and M. de Cadolle were mutually pleased to discover that they had adopted the same plan of classifying facts. De Candolle describes the method in his '*phytologie*', and in his sketch of my father mentions the satisfaction he felt in seeing it in action at Down. Besides these portfolios, of which there are some dozens full of notes, there are large bundles of MS. marked "used" and put away. (pp. 127-129).

Every year more Darwin material becomes available, such as Cambridge University's ongoing *Correspondence of Charles Darwin* project (see Appendix E below). Hence, a strong case can be argued for more in-depth study of Darwin's information behaviors due to this abundance of data sources, particularly as he has largely been ignored by the information science field despite convincing indications of Darwin's connections and relevance to information.

7. Darwin's information network

Darwin's information acquisition process and network is a useful means for studying the nexus of Darwin and information. Given the emerging state and inherent limitations of 19th century technology and transportation modes, Darwin's information acquisition process and information/communication system displays a surprising level of complexity and global scope. Certainly a large extent of the facts and information attained by Darwin throughout his life were collected with his own hands, eyes, and ears, such as the many physical specimens and journal-recorded observations amassed during his *Beagle* voyage years. But especially in the post-*Beagle* years, many of the facts and information that Darwin acquired came to him through the actions and supply of others. This vital information delivery process was made possible through an extensive network supplying him with facts and information that—like a farmer operating multi-yield fields—Darwin prepped and planted, nourished and weeded, periodically harvested and sold, and consistently rotated and replanted. As Browne (1995) emphasizes:

> …[T]he "facts" [Darwin] collected represented a collaborative endeavour fully documented in his extensive correspondence… He built his theories out of information physically extracted from others. He knew how to charm, how to make people help him. And the collaboration was always hierarchical, with Darwin acting as a greedy spider, throwing out a thread here, pulling in a fly there. He was a "miser with facts," he gloated in middle age, accumulating them like treasure trove. By no means can the *Origin* be seen as an individual triumph. (p. xiii).

Darwin's information network was facilitated by his family name and lineage, his upper class social standing, and his door-opening status as a Cambridge alumnus. He was a scion of substantial wealth through not only the Darwin family branch but, most notably, by way of his maternal line: through Josiah Wedgwood, his grandfather and the famed pottery founder. Retrospectively analyzing his success in his autobiography, Darwin acknowledged a central advantage of his privilege: "I have had ample leisure from not having to earn my own bread" (Barlow, 1958, p. 144). Raby (1996) notes the importance of this point as well, explaining that "[T]he Darwin and Wedgwood wealth ensured that he did not need to work for a living" (p. 27). The potential for lucrative mentor/mentee relationships characteristic of the British Victorian era, membership in professional associations and clubs like The Royal Society and The Athenaeum Club, and the like, were other significant personal and professional advantages enjoyed by Darwin due to his upper class standing. These advantages were also important with regard to Darwin's information behaviors.

Examination of a sample of letters by and to Darwin, accessible in the print volumes of *The Correspondence of Charles Darwin* (CCD) and via van Wyhe's The Complete Work of Charles Darwin Online (CWCDO), provides illuminating insights into and strong evidence of the importance of Darwin's global information network in facilitating Darwin's information behaviors. The first sample below comes from correspondence by and to Darwin during the 1831-1836 *Beagle* voyage. These excerpts provide some interesting examples of the British-based members comprising Darwin's network of information providers—family members, Cambridge classmates and former professors—as well as South American contacts, who facilitated Darwin's information seeking, communicating, and use during the *Beagle*'s forays in South America in 1832:

- *From John Maurice Herbert (barrister and fellow Cambridge alumnus) to C. Darwin, April 15-17, 1832*, in pertinent part:

  Henslow wished me to tell you that he has got your 17 Vol: of "La Dictionnaire Classique &c" description of the Plates.

- *From C. Darwin to Catherine Darwin (sister), May-June [1832], Botofogo Bay, Rio de Janeiro*, in pertinent part:

  I have sent a list of commissions for poor Erasmus to execute.

- *From C. Darwin to John Stevens Henslow (Cambridge mineralogist and botanist; Darwin's teacher and mentor), May 18-June 16, 1832, Rio de Janeiro*, in pertinent part:

  I am well off in books, the Dic: Class is *most useful*.

  I am now collecting fresh-water & land animals…

  I have just returned from a walk, & as a specimen how little the insects are know.—Noterus, according to Dic Class. contains solely 3 European species…

- *From C. Darwin to Catherine Darwin (sister), July 5, [1832], Rio de Janeiro*, in pertinent part:

  Would ask Erasmus to add to the books—Pennants quadrupeds (if not too late) in my bedroom.--& Humboldt tableaux de la nature.—You cannot imagine what a miser-like value is attached to books, when incapable of procuring them.

- *From Erasmus Darwin (brother) to C. Darwin, August 18, [1832]*, in pertinent part:

  I find by a letter from Catty [sister, Catherine] that the packet sails on Friday, so I write this to tell you about your commissions, tho' I am afraid I shall hardly be able to get all your rattletraps in sufficient time to send them. Cuviers Mollusques are not to be had in London and are very dear & scarce. of all the books of travels only one was to be had an imperfect copy without the Atlas for three guineas & a half so I did not get…In short I have got none of them. I have got Humboldt Fragmens de Geologie et de Climatologie Asiatique which I suppose was the work you meant. The 8th vol of the Personal Narrative was not published. Leopold Von Buch's Travels by Jamieson were in Norway & not Sweden so I have got that in its place & hope it is right. Bohn was very civil & thought he remembered something about the Linnaeus but as you did not mention the Edition & there are so many of them he is not certain that he shall be able to procure you the sheets…If Bohn should fail, I will send you my Linnaeus which I have ordered up from Shrewsbury in case. Scoresby's Arctic Regions are not to be found at Shrewsbury, and as you did not seem very anxious about them I have not thought it worth while to buy them.

- *From C. Darwin to Caroline Darwin (sister), November 24, [1832], [Monte Video]*, in pertinent part:

  We are now Novemb: 11. beating down the river to Monte Video.—We stayed a week at Buenos Ayres…I saw a good deal of Mr. Hughes…; he obtained a great deal of information for me & has undertaken several troublesome commissions.

As it is a special favor, thank dear old Erasmus [brother] for writing to me & doing all my various commissions.

The second sample of letters below, from *The Correspondence of Charles Darwin* and van Wyhe's (2006) The Complete Work of Charles Darwin Online, covers the years 1845-1860. They present post-*Beagle* instances of Darwin's information seeking, communication, and use through his information network:

- *Letter from C. Darwin to Joseph Dalton Hooker (botanist), [January 7, 1845]*, in pertinent part:

  will send back the books, which have much interested me…Have you in your Library Capt: Porter's Voyage in the Essex (in the Pacific) I have long wished, but never been able, to see it?...Thanks for your offer of collecting facts about coral-reefs…[should] you meet anything about subsidence of the land in the Pacific, or about Elevation in out-of-the-way-Books, [I should] be very much obliged if you [would] note it.

- *Letter from C. Darwin to William Allport Leighton (1817 Shrewsbury schoolfellow and botanist), November 21 [1858],* in pertinent part:

  It is remarkably kind of you to take such great trouble in sending me the specimens & so full & precise an account of your observations…Thank you much for your permission to use anyhow your information…How many years have rolled over our heads since we were at school together, & how little we then thought we should correspond on scientific subjects!

- *Letter from C. Darwin to James Paget (surgeon-extraordinary to Queen Victoria) [October 15- November 19, 1859],* in pertinent part:

  It was extremely kind in you to bear in mind my strong wish to learn any facts on inheritance at corresponding ages, & on correlation of growth.

- *Letter from Thomas Henry Huxley (zoologist) to C. Darwin, August 6, 1860*, in pertinent part:

  The treatise to which Von Bar refers he gave me when over here, but I have not been able to lay hands on it since this letter reached me two days ago. When I find it I will let you know what there is in it.

- *Letter from C. Darwin to Asa Gray (American botanist), August 11, 1860,* in pertinent part:

  On my return home from Sussex about a week ago, I found several articles sent by you. The first article from the 'Atlantic Monthly,' I am very glad to possess.

8. Darwin's information management

Darwin's voracious appetite for facts and information remained unabated throughout a lifetime of information hunting and collecting. Indeed, statements like the following excerpt from a letter written by Darwin to his cousin, William Darwin Fox, who was a fellow insect collector and one of Darwin's most prolific information suppliers, exemplify this continual craving: "…I am very anxious to get some crumbs of information about yourself & the insects" (Browne, 1995, pp. 100-101). In addition, many letters, such as the "greedy for facts" instance providing the name for this dissertation and cited in the dissertation's introduction, palpably highlight Darwin's incessant yearnings for information. This hunger for facts, though, was tempered by a gourmet's sensibilities: discerning what facts and information to consume, what to discard, and what to stay away from altogether. It was his facility with managing and then maximizing the value of the information he acquired, as Dawkins (2003) relates, which arguably imbued him with one of his most potent competitive advantages over other Victorian era scientists:

> Darwin was not only a deep thinker, he was a naturalist of encyclopaedic knowledge and…the ability to hold it in his head and deploy it in constructive directions. He was a master encyclopaedist, who collated huge quantities of information and observations solicited from naturalists all around the world. (p. 66).

Herbert (2005) provides a well-detailed example of Darwin's meticulous and skillful information organization. The example is a veritable how-to primer on Darwin's general cataloging methods for specimens recounted in his post-*Beagle* (1839) *Journal of Researches*. Occurring decades before the late 19th century's library organization and classification contributions of pioneers Melvil Dewey and Charles Cutter, this excerpt underscores the prescient nature of his information behaviors and his tendencies for order, assignment, and attention to detail:

> Put a number on every specimen, every fragment of a specimen; and during the very same minute let it be entered in the catalogue, so that if hereafter its locality be doubted, the collector may say in good truth, "Every specimen of mine was ticketed on the spot." Any thing [sic] which is folded up in paper, or put into a separate box, ought to have a number on the outside (with the exception perhaps of geological specimens), but more *especially* a duplicate number on the inside attached to

> the specimen itself. A series of small numbers should be printed from 0 to 5000; a stop must be added to those numbers which can be read upside down (as 699. or 86.). It is likewise convenient to have the different thousands printed on differently coloured paper, so that when unpacking, a single glance tells the approximate number. (Herbert, 2005, p. 101).

9. Darwin's influence

Focusing specifically on the LIS field, Darwin's influence on fundamental aspects of librarianship and information science persuasively demonstrates the rationale, significance, and need for studying Darwin's information behaviors. Discussing library classification, for example, Shera's (1965) *Libraries and the Organization of Knowledge* writes that "Brunet died too early to be influenced by Darwin, but both Dewey and Cutter, and especially the latter's principle of expansion, were deeply influenced by the doctrine of evolution"(p. 133). More broadly, Darwin's profound and lasting influence on global culture and science renders him a logical subject for a study of this nature. Dawkins (2003) writes that, "The distinguished American philosopher Daniel Dennett has credited Darwin with the greatest idea (natural selection) ever to occur to a human mind" (p. 66). Though Dennett's statement is an unverifiable assumption, his assessment of Darwin's inventive preeminence is certainly shared by many others in the scientific community. What can be said with more evidentiary-based certainty is that Darwin acted upon and was accorded first priority for the idea of natural selection.

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Desmond and Moore (1991) reinforce Dennett and Dawkins's view of Darwin as situated at the summit of scientific discovery and impact. They opine that "We now know more about the piecemeal, day-by-day development of Darwin's evolutionary views than about any other scientific theory in history. But then we need to; no other has been so shattering" (p. xix). Books and studies about Darwin abound. So, Desmond and Moore explain why the world needs another, like theirs. They argue that their biography of Darwin is needed in order to provide a post-modern historical epistemology in contrast to the earlier focus of censor-prone stewards of Darwin's work "in securing Darwin's immortality: But today's needs are different. We want to know about his personality, his business acumen, his domestic life, and his science. We want to understand how his theories and strategies were embedded in a reforming Whig society" (p. xix).

Building upon the research foundation of historical works about Darwin, such as Desmond and Moore's (1991), a strong argument can be made supporting the need for and significance of this dissertation on Darwin's information needs and behaviors. Given Darwin's established relevance to LIS, we need to know what Darwin's information needs were; how he sought, organized, managed, communicated, and used information, and whether his information needs and additional information behaviors can be depicted in an illustrative model to enhance understanding. Intriguing, but beyond the scope of this dissertation, as explained further in the Areas for further research section below, are questions about how Darwin's information needs and behaviors changed and evolved over his lifetime. In support of this line of future research inquiry, several instances from Darwin's (Barlow, 1958) autobiography identified during this dissertation suggest Darwin's own sense of his information behaviors' change and evolution:

> I have become a little more skilful [sic] in guessing right explanations and in devising experimental tests; but this may probably be the result of mere practice, and of a larger store of knowledge. (p. 136).
>
> My mind seems to have become a kind of machine for grinding general laws out of large collections of facts, but why this should have caused the atrophy of that part of the brain alone, on which the higher tastes depend, I cannot conceive. (p. 139).

One can hypothesize on reasonable foundation, thus, that Darwin's information behaviors—information collection, organization, and use—were important factors in the creation of his influential ideas and theories. But for Spink and Currier's (2006b) exploratory study identifying several instances of Darwin's information organization and use, however, no prior library and information science-oriented studies were found that have methodologically investigated and identified Darwin's information needs or behaviors.

10. Darwin as research subject

From a general scientific standpoint and even more specifically from a LIS research perspective, Charles Darwin's information needs and behaviors constitute an original, cogent, and highly relevant topic for substantive examination. Augmenting the rationale, significance, and need for this Darwin dissertation is (1) the breadth of extant material available for study, and (2) the significant amount of that material which has provenance from Darwin's own hand and in his own voice, which mitigates some of the inherent difficulties and limitations in studying the "dead past" via historical methods. Darwin's son, Francis, discusses the large quantity of information made available by Charles Darwin's own writings, which intentionally and unintentionally reveal much about himself. Francis concludes that, "With such excellent documentation, it is possible to know Darwin as well as any man of his period" (Darwin, 1898, pp. xiv-xv.). Despite decades of analysis and countless works scrutinizing his life and work, Darwin researchers continue to study and investigate Darwin, enticed by the prospects of uncovering as-yet-unknown aspects of him as well as opportunities for reanalyzing and reinterpreting that which is already known and well-documented. Additional information about Darwin may yet remain to be discovered and interpreted. This notion is typified by Veak's (2003) study "Exploring Darwin's Correspondence", in which he quantitatively and qualitatively examines Darwin's 14,000+ extant letters and suggests that as-yet-untapped information remains in Darwin's correspondence.

11. Challenges and opportunities in studying Darwin

Studying Charles Darwin's information behaviors presents potential uncertainty and significant challenges. This is evinced by Francis Darwin's (1898) caveat: "Yet the mystery of what factors contributed to his greatness is not wholly dispelled, nor are the depths of personality all laid bare. In some respects the evidence is equivocal; in others it simply does not exist" (p. xv.). Biographers of Darwin also concede the difficulties in studying and explaining Charles Darwin, as expressed by Browne (1995):

> Although more has been said or written about Charles Darwin than about any other scientist, and great libraries of his books and papers have been established in England and America, his house turned into a museum, and collections of his manuscripts brought together at considerable cost, the individual behind the fuss remains elusive…His autobiography and the path of history

> itself have thrown up a smoke screen almost as effective as if no records had been left behind at all. (pp. x-xi).

On the other side of the scale, though, there are a number of reasons to suggest that much can be gleaned and understood about Darwin. One very important reason remains the breadth of Darwin information that has become more and more accessible for study and analysis as various Darwin materials are transcribed, edited, and published in print formats. New information continues to surface from time to time too, as previously undiscovered Darwin letters are serendipitously located, acquired, and eventually made available by Cambridge for study. Moreover, as this dissertation demonstrates, Darwin-related sources are increasingly accessible in electronic formats, which opens up novel ways for searching, such as by keyword. Another important factor facilitating greater understanding of Darwin is that a great deal of the information about him derives from Darwin himself, in the form of thousands of linear feet of primary source materials. All of these factors strengthen the arguments for the rationale, significance, and need for this examination of Darwin's information needs and behaviors. This may promote enhanced understanding of Darwin's information needs and behaviors and provide some illustrative models. An objective and intended upshot of this study is that another dimension of Darwin may emerge beyond the conventional conceptual roles of "Darwin the biologist" or "Darwin the natural historian", by reframing him as, for example, "Darwin the information manager." With regard specifically to the LIS field, this study may contribute to greater understanding of Darwin's important relationship with information. At a minimum, it is hoped that this study demonstrably evinces Darwin's relevance to library and information science and early information technology and management.

D. RESEARCH QUESTIONS

This dissertation investigated four principal research questions:

1. The following two parts of this question were posed in the dissertation proposal: "What were Charles Darwin's information behaviors? More specifically, what information did Darwin need and how did Darwin seek, organize, and use information?" Once the dissertation was underway, it was decided to expand the second part of this question by adding the words "manage" and "communicate". Hence, the question was amended to , "More specifically, what information did Darwin need and how did Darwin seek, organize, manage, communicate, and use information?"

2. Within what contexts did Darwin manifest his information behaviors? How did such contexts influence Darwin's information behaviors?

3. Did Darwin's information needs and behaviors change/evolve over his lifetime, and if so, how?

4. What model(s) can be developed to explain and illustrate Darwin's information behaviors and potential changes/evolution of his information behaviors?

E. THEORETICAL FRAMEWORKS AND EPISTEMOLOGIES

This dissertation has several overarching frameworks and epistemologies. Firstly, its area of concentration is within the LIS subfield of human information behavior. Secondly, this dissertation is situated within a constructivist epistemology regarding its approach to information as a construct of the conscious human mind.

F. LIMITATIONS

All research has limitations and this section will discuss some limitations of this dissertation research. Firstly, this dissertation is not an exhaustive examination of all extant Darwin letters and writings. Several hundred of the more than 14,000 extant Darwin letters, written and exchanged between Darwin and approximately 2,000 correspondents, were examined. Therefore, future research of letters that were not analyzed in this study may identify and derive more Darwin-related information behavior categories than those which were presented in this study. The DIB subcategories were identified and derived from analysis of Darwin's own words from his letters and writings and were supplemented by scholarly Darwin secondary sources; they reflect the subjective judgment of the researcher. The same is true for the five BCIB categories that overarch the DIB subcategories. As a result, opinions will likely vary as to whether some category and subcategory headings could or should have been named differently, conflated, bifurcated, omitted, added, and so forth. In order to reduce the improper transfer of 21st century conceptions of information to a 19th century context, it was decided to derive and use as many DIB categories as necessary and warranted, by capturing Darwin's own information behavior-related descriptions of his actions, rather than collapsing his information behaviors into fewer and more inclusive categories and subcategories. This dissertation is of an exploratory nature, in terms of not building directly upon a prior LIS-oriented study of Darwin's information needs and behaviors. It can be characterized as a preliminary LIS research step in studying his information behaviors. Hence, one of the key objectives of the study was to "collect" or inventory Darwin's information behaviors in order to enable further analysis, understanding, and explanation of them. Additional research may suggest modifications to the nomenclature that was employed in this dissertation to identify and classify Darwin's information behaviors, as enhanced LIS-based understanding of his information behaviors develops.

The dissertation's focus upon one individual is a limitation which limits its generalizability. This is often the case in qualitative and quantitative research where a study's subjects are few or the data sampling set is small. The BCIBs and DIBs developed through this study were derived from the writings and work of Darwin and applicable secondary sources. Consequently, the information behavior categories and subcategories are specific to him. However, though they relate specifically to Darwin's own information behavior-related internal and external actions, other persons may share some of these information behaviors in common with Darwin. As a case in point, some of Darwin's information behaviors share common features with the information seeking activities of Ellis et al.'s (1993) contemporary British social scientists, physicists, and chemists, such as extracting and verifying, even though Darwin and Elis et al.'s scientists are separated by more than a century. Ellis et al. also identified an information seeking behavior that they termed chaining, for which some evidence was found in relation to Darwin within a few secondary sources. Hence, although the subject of this dissertation is one individual, because HIB is an emerging LIS subfield that is beginning to look more at the information behaviors of pre-Information Age individuals and groups, this Darwin study can be seen as a foundation from which to build and compare and contrast other similar and relevant studies. Indeed, Ellis et al. (1993) builds upon Ellis's (1989) study of the information seeking behaviors of social scientists by adding physicists and chemists, and then comparing and contrasting the behaviors of the three groups. In a similar fashion, this dissertation may have some applicability and generalizability to these already existing studies of scientists, as well as added studies of scientists from Darwin's and other time periods. For example, this research may be relevant for researching the information behaviors of other 19th century scientists, such as Alfred Russel Wallace, Charles Lyell, Thomas Henry Huxley, and Alphonse de Candolle, and scientists from different periods, as mentioned in this dissertation's Discussion and Areas for further research sections. As such, the BCIBs and DIBs inventoried and described in relation to Darwin may have some applicability and utility for studying others in his peer group and comparing and contrasting their information behaviors. Moreover, the BCIB and DIB categories may be applicable to and useful for studying the information behaviors of scientists from earlier and later time periods.

A limitation which needs to be acknowledged pertains to the accuracy of the interpreted meaning of Darwin's statements in his letters and writings, as well as those of other correspondents that are referenced in this dissertation. Namely, though Darwin's express words might seem to indicate that he performed certain actions, this does not mean that he did, in actuality, follow through on his stated intent to perform such actions. A case in point is an 1849 letter in which Darwin wrote to Joseph Dalton Hooker that the latter's letters having "portions which did not contain any facts which I wanted to refer to again have been spitted & the other parts put in my portfolios" (DCOD, Letter 1239, 9 April 1849). However, an accompanying editorial footnote states that there is no evidence that Darwin "spitted and divided" Hooker's or Lyell's letters (DCOD, Footnote 3, Letter 1239, 9 April 1849). Again, however, the footnote also adds that "not all the surviving letters are complete", so the issue remains unresolvable (DCOD, Letter 1239, Footnote 3, 9 April 1849). These cited editorial footnotes demonstrate the importance of using scholarly secondary sources to verify or disconfirm the meaning of information in the primary sources. With regard to the Darwin letters, utilizing Cambridge's footnotes helps to mitigate potentially inaccurate interpretation of their content.

Another limitation of this research relates to Darwin's notoriously illegible handwriting: its challenging quality essentially mandates the use of edited and transcribed publications of Darwin's writings and letters, except for those with significant experience and expertise in deciphering his printing and penmanship. In truth, even those closest to him found his handwriting difficult to comprehend. An amusing but insightful passage demonstrates this point. In an 1839 letter by Darwin to his fiancée, Emma, shortly before they were to be married, he refers to Emma's comments about his handwriting:

> And this puts me in mind to give you another *scolding* for sending me those *square* little sneers about my writing.— who ever read hieroglyphics, without the context, & is not my hand

> more like hieroglyphics than common writing? Bad hand as it is, it serve me to tell you, you are my own dear Emma, & there is an end of my *scolding*! (DCOD, Letter 484, [6-7 January 1839]).

Scholarly opinions vary on his handwriting's legibility, however. Curiously, Armstrong (1985) finds that, "His writing is generally quite legible, although the modern eye has difficulty with the occasional word: he seems sometimes to have written at considerable speed" (p. 8). But, Vorzimmer (1977) opines that, "Although the penmanship of Darwin's amanuensis was excellent, Darwin's own hand is very difficult to read" (p. 109). Relating the "problems" in transcribing Darwin's reading notebooks, he explains that, "Darwin usually had more than 25 lines to a 7-inch notebook page. Since his writing is hard to read and often indecipherable without the constraints of such size, the reading of these holograph notebook pages was extremely difficult" (p. 109). Nicholas and Nicholas (2002) concur, discussing Darwin's first comments about Australia, which he recorded in a notebook: "Written on the impulse of the moment, and often in a great hurry, the words are not easy to decipher, and some are illegible" (p. 23). The consensus of opinion gleaned from this dissertation research is that Darwin's handwriting's legibility is a challenge, and in some instances an insurmountable impediment, to decipher and understand with certainty; transcriptions, in fact, note words in Darwin's letters that are unreadable. Thus, reliance on transcribed and edited publications of Darwin's correspondence, such as Cambridge's definitive print CCD volumes or the electronic DCOD and CWCDO, is highly advisable; from the experience of this dissertation, it is also a necessity. First-hand experience with examining Darwin's original notebooks and letters that are housed at Cambridge University Library, as well as perusal of copies of Darwin's letters which are kept at Philadelphia's American Philosophical Society, highlighted the formidable comprehension difficulties and possible interpretive pitfalls which are inherent for researchers who are analyzing Darwin's unedited and untranscribed writings. In addition, misspellings and other grammatical issues in Darwin's writings can present obstacles to reliable comprehension and interpretation. Browne (1995) points out, for instance, in a passage discussing the types of fish that Darwin ate on the *Beagle*, that barracuda was "spelled "Barrow Cooter" in Darwin's diary" (p. 222). Armstrong (1985) remarks that "His spelling is not altogether consistent" (p. 8). An editorial note on one of this study's Darwin letters stated that his insertion of a punctuation mark made the meaning of that particular passage ambiguous to even himself, upon his referral to it years later. Armstrong (1985) observes on this point as well that, "His punctuation and use of capital letters sometimes appear fairly arbitrary" (p. 8). The result of such problems with interpreting and transcribing Darwin's handwriting is that in some cases indecipherable words have had to be conjectured by Darwin scholars, which can potentially trigger validity issues.

Another argument for the importance and necessity of reading transcribed and edited versions of Darwin's letters is his habit of not dating letters. As Armstrong points out, "Charles didn't always give the full date" (p. 8). Hence, as explained earlier, Darwin experts have had to use other relevant cross-indexing Darwin sources to attempt to date undated letters as accurately as possible. The Introduction to CCD, Vol. 7, 1858-1859 offers an illustrative example:

> As was his custom, Darwin did not supply a full date on his letter to Lyell. He simply dated the letter "18" and referred to Wallace's letter as having been received "today". Following Francis Darwin (*LL* 2: 116—17) and relying on Charles Lyell's endorsement, the editors have dated the letter 18 [June 1858]. However, the

> accuracy of Darwin's words has been questioned by John L. Brooks and by H. Lewis McKinney, both of whom believe that Darwin received Wallace's communication before 18 June. (pp. 5-6). http://www.lib.cam.ac.uk/Departments/Darwin/intros/vol7.html, accessed October 2, 2006.

In addition to not consistently dating his letters, Armstrong (1985) notes that Darwin was sometimes mistaken as to the dates he wrote, though "very rarely" (p. 8). He provides an example, showing that, "a page of his notes on the Cocos-Keeling Islands is dated 1835, yet in fact he visited that archipelago in April 1836, *after* having visited Western Australia" (p. 8). The DCOD editorial footnotes also describe occasional errors that Darwin made in his work and writings. As explained in the Discussion section's identification of Darwin's verifying and confirming information behaviors, though, he was generally meticulous about not making mistakes. Emphasizing his punctilious nature, in fact, Darwin was prone to noting and telling his correspondents about the errors that he found in others' writings.

III. LITERATURE REVIEW

The following overview identifies a significant number of studies and works relevant to this dissertation:

A. EVOLUTIONARY PERSPECTIVE-RELATED STUDIES

Within the fields of IS and HIB, a number of studies examine the concept of information from an evolutionary perspective. Spink and Currier (2006b) identify the information behaviors of eight scientists, academics, and military leaders from the past in an exploratory study that also expounds the rationale and need for an evolutionary approach. Strengths of the study are the researchers' discussion of why the eight subjects were chosen, as well as disclosure of other subjects who did not yield usable data in this study. Both a strength and weakness of the study is its exploratory nature: it explains the rationale and need for a paradigmatic shift within the human information behavior field but has a limited amount of research data upon which to substantiate its arguments in support of an evolutionary approach.

Another weakness of the study is a paucity of context for each person examined in the study. Such context might help to better illuminate the significance of each person's identified information behavior examples. Other shortcomings are its lack of cultural diversity and gender parity: all eight of the persons studied are of Western origin and only one is female. A plus of the study is its reporting of various historical information behaviors, using the actual self-reported words of its subjects to identify, for instance, Napoleon's record-keeping, Booker T. Washington's personal library construction, John Stuart Mill's abstracting, and Charles Darwin's indexing and cataloging.

Spink and Currier (2006a), discussed in part earlier, expand upon their Spink and Currier (2006b) exploratory study to provide an initial chronology of HIB studies and further develop an emerging evolutionary approach for HIB. Many scientific disciplines have created chronologies showing the evolution of humans and human behavior. Spink and Currier (2006a) point out Avery's (2003, p. 111) and Leakey and Lewin's (1977, pp. 198-199) use of a chronology to show human brain size increases; Mithen's (1996) chronology depicting the evolution of human intelligence over a period of millions of years (p. 211); and Settegast's (1986) B.C. chronology of ancient human cultural development. Chronologies like these can be beneficial to scientific research, such as in facilitating data organization and analysis (Spink & Currier, 2006a). A strength of the study is its articulation of specific questions for further research. The chronology, though useful as a schema for organizing and depicting HIB-related studies in a linear manner, would be enhanced by expanding it to include more studies, which is acknowledged in the study. Its focus on HIB-related studies with a predominantly Western viewpoint may be seen as lacking generalizability to broader segments of the world population. However, a key point is that the study is a starting point for further studies and chronologies of this nature.

Toward the goal of expanding the study of human information behaviors from a largely post-1900 perspective to one that encompasses the wide span of human existence, Spink and Currier (2006a) provide an initial chronology of various identified studies focused on persons of the past and pertaining to aspects of their human information behaviors and relationships with information:

Time →

Evolution →

Upper Paleolithic Era 10,000-70,000 Years Ago	Classical Greece 8th Century B.C. to 2nd Century B.C.	Renaissance 1454 A.D. to 1699 A.D.	Industrial Age 1700 A.D. to 1945 A.D.	Post-Industrial Information Age 1946 - 21st Century
Mithen (1988) - Art and Information Gathering	Payne (1993) - Information Collection and Transmission	Spink & Currier (2006a; 2006b) - Leonardo Da Vinci	Spink & Currier (2006a; 2006b) - Napoleon, Darwin, Casanova, Mill, Booker T. Washington, Freud, Payne-Gaposchkin	Madden, (2004)
Ouzman, Tacon, Mulvaney & Fullagar (2002) - Cave Art and Information	Russell (1999) - Information Gathering			Case (2002) - Post World War II Information Behaviors
Pfeiffer (1982) - Cave Art and Information				Wilson (2000) - Post World War II Information Behaviors

Figure 2. Initial chronology of studies illuminating various aspects of HIB over the span of human existence. (Spink & Currier, 2006a, p. 19).

Bates (2005) analyzes fundamental information science terms, such as information, with the aim of promoting interdisciplinarity and an evolutionary perspective for information studies. A strength of her study is its discussion regarding how information science can benefit from "seeing the value" in "newer social science metatheories" like evolutionary theory. Bates asserts that such evolutionary inquiry may "enrich our understanding of information" and contribute to interdisciplinary definitions of information. Though beneficial as a primer on fields using an evolutionary perspective, one limitation of this exploratory article is that it principally is an essay, as Bates labels it, about definitional aspects of information, which does not present hard data. Other limitations are its lack of both a coherent and well-developed framework and a model of the study's conclusions.

Madden et al. (2006) describe information seeking in pre-literate societies and discuss aspects of human evolution. The study examines the information sources and information roles used by members of an existing "technologically unsophisticated" Papua New Guinea tribe of roughly five thousand people; one of the researchers is a member of this tribe. A shortcoming of this study is the isolated, relatively small nature of its population, which may yield low generalizability. However, the researchers acknowledge that argument, offering a cautionary note about "generalizing from a single instance." A strength of the study, though, is its unique population: human beings descending from traditional hunter-gatherers, without Western contact until 1930, who engaged in oral information transmission. Madden (2004) also discusses information and human evolution.

Researchers in non-IS fields have contributed studies involving the evolutionary perspective, which are relevant to and provide interdisciplinary precedent for an HIB evolutionary approach. Barkow, Cosmides and Tooby (1992) discuss the evolutionary perspective and conceptual integration by various scientific disciplines. Tooby and Cosmides (1989) emphasize the evolutionary perspective's power in discovering, inventorying, and analyzing innate psychological mechanisms. Stonier (1997) discusses an evolutionary perspective for information. Carroll's (2000) "Towards a New Evolutionary Synthesis" suggests the need for integrating more recent evolution-related information and concepts attained by diverse scientific fields "into an expanded evolutionary synthesis", in order to facilitate and expand evolutionary research and education. Avery (2003) discusses information theory and aspects of human cultural and genetic evolution.

The studies of a number of researchers, many of which Spink and Currier (2006a) cite and review in their chapter "Emerging Evolutionary Approach to Human Information Behavior", have suggested a relationship between information and diverse art/communication formats, like ancient cave art, rock art, and engravings. These communication formats can be interpreted, at least in part, as indicia of tools developed, used, and evolved by humans for early information technology management. Mithen (1988) discusses the role of art vis-à-vis information gathering and use by people of the Upper Paleolithic period. Mithen (1996) posits that cave paintings and ivory plaques, created and used by Upper Paleolithic human beings for recording information, can be analogized as 'artificial memory systems' and precursors of modern-day CD-ROMs and computers. Ouzman, Tacon, Mulvaney and Fullagar (2002) consider whether ancient Aboriginal Australian rock art carvings can be viewed as a means of transmitting Aboriginal thoughts and information across the human generational span of time. Pfeiffer (1982) proposes that Europe's celebrated prehistoric cave paintings can be interpreted as the advent of "the Information Age"; he suggests that cave art may have been a type of "tribal encyclopedia" and that the very placement of cave paintings at precise locations within cave systems "implies a system of classification" and "a hierarchy of knowledge" (pp. 127, 227-228). Kaplan (1992) considers Pfeiffer's (1982) hypothesis that cave paintings were an important means for Upper Paleolithic people to record and store information and concludes that the "evidence, while far from overwhelming, suggest the likely significance of information to human evolution" (p. 583).

Scientists and researchers for centuries have pondered the purposes of information embedded in ancient artifacts and technologies. Haycock's (2004) "'The Long-lost Truth': Sir Isaac Newton and the Newtonian Pursuit of Ancient Knowledge" recounts 18th-century science's frequent association of ancient monuments like Stonehenge with religious truths and "original knowledge" descending from the Bible's Adam, Moses, and Noah; Newton viewed Stonehenge as "evidence for the Ancients' belief in the heliocentric system". Reed (1995) notes that convincing evidence exists that Stonehenge functioned, at least in part, as a type of astronomical calendar.

A number of North and South American-based studies examine issues and instances of information and centuries-old communication forms. Haddon (1895) discusses the use of pictographs created by North American Indians as a medium for recording and conveying information. Haddon suggests various purposes these pictographs served, such as providing “warning and guidance”, “charts of geographical features” and “record of expedition”, asserting that some of the pictographs “contain some material that is absolute and veritable tribal history” (pp. 206-212). Bettina (1994) looks at the use of *quipu*—knotted strings used by ancient Peruvians for calculating and keeping records—as a method for information transmission. Christensen (2002) explains the use of quipu for Incan mathematical notation.

In addition to Spink and Currier’s (2006a; 2006b) and Bates’s (2005) evolutionarily-oriented approaches for HIB, other researchers have suggested frameworks for HIB. Spink and Cole (2005) provide a preliminary framework for various HIB conceptual approaches. Cole and Leide (2006) present a cognitive framework for HIB organizing behavior. Hargittai and Hinnant (2006) provide a social framework for information seeking. Sonnenwald and Iivonen (1999) offer an integrated HIB research framework based on Ranganathan’s approach for knowledge organization.

B. HIB-RELATED STUDIES OF INFORMATION NEEDS, SEEKING, AND USE

Researchers have amassed a significant body of studies on the information needs, seeking, and use behaviors of various contemporary individuals and populations. The following select sample from the larger universe of these studies highlights the diverse research methodologies used to study lone subjects as well as groups. Chatman (1999) studies the information needs and information uses of female prisoners by means of ethnography. Chatman (1996) also employs a chiefly ethnographic participant observation method to study the information needs and use behaviors of Louisiana janitors. Chatman (1992) utilizes ethnography to uncover the information needs and uses of older women living alone in a retirement community. Baker (2004) uses content analysis to study the information needs of one subject: a dying husband. Cobbledick (1996) studies the information seeking behaviors of artists via an exploratory interview approach. Fisher et al. (2004) uses Pettigrew's (1999) findings and theory on *information grounds* to study the use of need-based services by New York City immigrants. Pettigrew (1999) defines an information ground as an "environment temporarily created by the behavior of people who have come together to perform a given task, but from which emerges a social atmosphere that fosters the spontaneous and serendipitous sharing of information." Examples of potential information grounds, Pettigrew (1999) suggests, include health clinics, beauty salons, and playgrounds.

C. HIB-RELATED STUDIES OF SCIENTISTS, ACADEMIC RESEARCHERS, AND PHYSICIANS

As discussed in the section above, many HIB studies have examined the information behaviors and needs of people who have been categorized by criteria like vocation, social roles, and demographics. A large number of studies have investigated the information behaviors and needs of scientists and academic researchers, as well as the medical profession, which melds aspects of scientific research and academe. Studies like these may be particularly relevant to a study of Darwin's information behaviors because of his varied roles as scientist and researcher, and his medical training.

In addition, analyzing and incorporating Darwin's Victorian era scientific contextual environment, such as the invisible college milieu of contemporaries upon whom he relied significantly for information, is vital. This is particularly true in examining and striving to understand Darwin's information behaviors, especially in relation to the present as well as other time periods. In their seminal biography of Darwin, Desmond and Moore (1991), for example, strongly entreat this need for contextual analysis:

> We have to see [Darwin] as part of an active Whig circle… Appreciate Darwin's attitude to the workhouse culture, and his science acquires a deeper political meaning…So far this wider context has been largely ignored…Social historians have consistently failed to follow up, to re-locate Darwin in his age. As a result we have lost sight of the larger world that made Darwin's evolution possible. (p. xx).

Browne's (1995) copiously-detailed Darwin biography similarly underscores the importance of looking at Darwin in the context of his era and that era's attendant characteristics and ethos in order to pierce Darwin's veil. For Browne, broader context is paramount and "[Darwin's] story is the story of the era" (p. xiii):

> Darwinism was made by Darwin *and* Victorian society. Yet for all the continuing interest in Darwin's work and personality, remarkably little attention has been paid to the way he lived out his life on this interface: to his life as a gentleman-naturalist in an age when science first became prominent in British society, as a friend of eminent men, a traveller, husband, and father, a best-selling author, a dedicated experimenter, and a shawl-clad Victorian invalid…[N]one of the influential thinkers, scientists, and philosophers of any historical period were "born" in this simple sense…[F]igures like himself were the product of a complex interweaving of personality and opportunity with the movements of the times. (p. xi).

A selection of information studies on scientists and researchers illustrates the kinds of research conducted on these populations. Ellis, Cox and Hall (1993) investigate and compare the information seeking patterns of researchers in the physical and social sciences. Their study builds upon a previous Ellis (1989) study, which generated a model describing the information seeking behaviors of academic social scientists. Ellis et al. explain that studies examining the information seeking behaviors of scientists began around the late 1940's. They cite the work of Skelton (1973), who writes that science user studies are problematic, "composed of a large body of data that cannot be correlated, due to differing objectives, methodologies, samples, scales, and definitions used by the studies" (p. 356). Thus, Ellis et al. emphasize that the chief goal of their study is to try "to rectify these defects" (p. 357). Specifically, their objective is to "derive behavioural models of information seeking patterns of academic physicists and academic chemists employing a method similar to that used by Ellis [1989]" (p. 357). Ellis et al.'s research method consisted of personal interviews with 18 physicists and 14 chemists in the UK. Data analysis was conducted using grounded theory, also referred to as the constant comparative method. Ellis (1989) identified six categories describing the information seeking activities of the academic social scientists. Ellis et al. (1993) note that because the nomenclature and definitions of the categories were standardized with Ellis (1989), they were able to employ Ellis's six categories, to which they added two new categories that emerged regarding the chemists' information seeking activities. The eight categories, defined in the study, are starting, chaining, browsing, differentiating, monitoring, extracting, and the two Ellis et al. (1993) categories, verifying and ending. Discussing the generalizability of their models and the relationships of the eight different categories, Ellis et al. make several important points:

> [The information seeking models of the physicists, chemists, and social scientists] can be used to describe any individual pattern of information seeking behaviour. However, the models do not attempt to define the interactions and interrelationships between the categories or the order in which they are carried out. The nature of the relationship between the features of the models can only be described in relation to specific information seeking patterns. Therefore, although it is possible to describe relationships between the features at a general level, the exact relationship of the features of the models depends upon the circumstances associated with the information seeking behaviour of a particular individual at a particular time. (p. 359).

The study's chief conclusion is that the information seeking activities of the physicists, chemists, and social scientists displayed "a remarkable degree of homogeneity"; differences found among them were not major and were characterized as "differences of emphasis" (p. 366).

An observation about Ellis et al.'s sample is that 11 of the 18 physicists were Ph.D. students, most likely reflecting the common practice of utilizing students from local academic institutions as convenience samples. Though perfectly acceptable to do so, it is worth noting, as perhaps the information seeking patterns of more seasoned physicists might have produced some differences. One also wonders whether differences in information seeking patterns might have been observed if, say, the exclusively UK sample in this study were compared with a representative sample in North America, Europe, or Australasia. Might some patterns be influenced by institutional cultures as well? It should also be noted that this study is essentially pre-Internet, so with the ensuing proliferation of electronic communication a similar study's findings might reveal some differences or changes regarding the information seeking activities of the scientists and researchers.

As an example of a post-Internet information seeking study, Meho and Tibbo (2003) reexamine Ellis's (1989) study identifying six categories of information seeking activities of social scientists. They interviewed social science researchers who were studying stateless nations. Meho and Tibbo "confirmed Ellis's model" but determined that four more information seeking features should be added for their study population (p. 570). The four features are accessing, networking, verifying, and information managing, which were combined with Ellis's (1989) six categories to create a new model. The new model, "unlike Ellis's, groups all the features into four interrelated stages: searching, accessing, processing, and ending" (p. 570).

Other information-oriented studies also examine different aspects of scientists and researchers. Gorman (1995) delves into the information needs of physicians. Gould and Handler (1989) study information needs in the social sciences. Folster (1989) examines the use of information sources by social science researchers. Watson-Boone (1994) inspects the information needs and habits of humanities scholars. Kraut, Egido and Galegher (1990) scrutinize patterns of contact and collaboration in scientific research collaboration. Poland (1991) peruses informal communication among scientists and engineers. Rice and Tarin (1993) discuss scientific communication and the use of information sources within disciplines. Cronin (1982) describes invisible colleges and information transfer in the social sciences.

D. HIB-RELATED STUDIES USING HISTORICAL METHODS

Various historical method studies with human information behavior foci have been conducted. Richmond's (1988) "Hand and Mouth: Information Gathering and Use in England in the Later Middle Ages" uses a historical method approach. Payne's (1993) **"**Information Collection and Transmission in Classical Greece" and Russell's (1999) *Information Gathering in Classical Greece* are also examples of studies utilizing historical methodology. Interestingly, Russell (1999) examines the information behaviors—focused on intelligence gathering—of specific persons, like Alexander the Great and Plutarch, as well as groups of people, such as spies, servants, slaves and prisoners.

Richmond (1988), Payne (1993), and Russell (1999) involve a range of issues related to historical research, which will be addressed in greater detail in the methodology section of this proposal. These studies rely upon primary and secondary documents. Payne (1993) and Russell (1999) have the added obstacle of depending upon materials that derive from a much earlier historical period, i.e. Classical Greece, where surviving historical documents and materials are in much less quantity than Richmond's (1988) significantly later historical period. Moreover, Payne (1993) and Russell (1999) must confront linguistic issues, vis-à-vis the translated quality of the Classical Greek materials that they survey, compared with Richmond (1988) who ostensibly may more easily contend with potentially less formidable 15th century English.

Case (2002) analyzes Richmond (1988) and describes the study as "fascinating" and an "ambitious act of narrative and understanding" (pp. 208-209). However, Case also notes that "like other studies in history", the study's "lack of evidence", "biased personal accounts of human motives and actions", and "selective use of what information exists" are weaknesses of the historical method approach used by Richmond (p. 209). To Richmond's credit, Case (2002) notes Richmond's acknowledgement of these weaknesses. (p. 209). Case concedes that historical research's frequent necessity "of piecing together a narrative with incomplete evidence" requires researchers to employ a mixture of conjecture, reasoning, and creativity (p. 209).

E. HIB STUDIES USING CASE STUDY METHODOLOGY

Kuhlthau (1999) uses a case study approach to study a securities analyst who transitioned from an entering beginner to an experienced professional over the course of five years. Kuhlthau describes her (1999) study as "[a] longitudinal case study method…used to explore implications of the ISP [Information Search Process, Kuhlthau, 1994] theory in a work environment of intensive information seeking and use" (p. 402). Her study also used intensive interviews for data collection, thus adding another dimension to this case study approach. As Case (2002) observes, the motivation for Kuhlthau's (1999) study was interest in "the development of expertise among people who work in information-intensive jobs." (p. 181). Kuhlthau's (1999) study actually began in 1983, when the participant was in high school (p.

403). Interactions with the participant continued over the course of four- to five-year intervals. Case (2002) identifies Kuhlthau (1999) as "a good example of a case study" and states that "[i]n a fashion typical of case studies, Kuhlthau identifies both a fruitful environment for such studies (the financial services industry) and a willing respondent (about whom she already had some background data)" (p. 181).

Case (2002) analyzes some strengths and weaknesses of Kuhlthau's (1999) study. On the plus side, "purposeful selection of participants has the advantage of matching for characteristics useful to the study" and "to that end, case studies can reinforce validity" (p. 181). On the minus side, Case (2002) points out that this type of purposive sampling "can also introduce biases into a study" and "the reliability of the results can suffer" (p. 181). Case (2002) also raises a criticism of case studies, flagged above in the limitations section: "How much can we really learn from the details of one person's experience?" (p. 182). The perpetual issue with case studies, Case reminds, "is whether the unit observed (in this case, a particular securities analyst) is representative of others in the population (i.e., all securities analysts)" (p. 182). The fear, in short, is that the focus of a case study may be radically different or an aberration from the larger population of which the unit of study belongs.

In support of Kuhlthau's (1999) use of the case study method, Case points out that Kuhlthau "is not trying to generalize her findings to the entire population of securities analysts. Rather she is exploring a basic aspect of human information behavior" (Case, 2002, p. 182). Kuhlthau's (1999) participant is purportedly not radically different from all other human beings, which serves to not diminish her study's findings. As Case (2002) states, "case studies can have a cumulative effect; as further cases are investigated, we can compare findings and hope that they lead us in the direction of generalization" (pp. 182-183). Per Yin (2003), generalizing is the goal for those using a case study approach, not particularizing. (pp. 10-11).

Buchwald's (2000) "A Case Study of Canada's Coalition for Public Information in the Information Highway Policy-making Process" uses case study and grounded theory methodology. The case study component of the research focuses on in-depth study of one policy-making entity; the grounded theory prong follows Glaser and Strauss's (1967) grounded theory method steps of gathering, organizing, and analyzing data. Data was collected via observation of the policy-making entity, interviews, and analysis of documents. Buchwald uses NUD*IST™ software to organize her raw data into descriptive categories and then conceptual categories, and conducts other research strategies related to theory building, such as conceptualizing via field notes-cum-memo-writing.

F. HIB STUDIES USING GROUNDED THEORY

Ellis (1989, 1993) studies the information seeking behaviors of scientists. Through a grounded theory approach, Ellis develops eight stages—starting, chaining, browsing, differentiating, monitoring, extracting, verifying, and ending—to explain and model social scientists' information seeking behaviors. Pace's (2004) "A Grounded Theory of the Flow Experiences of Web Users" studies Internet users performing information-seeking activities. The data gathered in the study derives primarily from semi-structured in-depth interviews;

characteristic of grounded theory methodology, Pace states that the research's goal is theory building, rather than theory testing. Buchwald (2000), discussed above, is another example of a research study using grounded theory, in combination with a case study approach.

G. INFORMATION SCIENCE STUDIES USING HISTORICAL CASE STUDY METHOD

Wallace (1997) and Bastian (1999) use a historical case study method in their respective LIS dissertations. Wallace (1997) *The Public's Use of Federal Recordkeeping Statutes to Shape Federal Information Policy: A Study of the PROFS Case* blends historical research with case study methodology, ultimately utilizing a hybridized historical case study method. "Historical case study research", Wallace states, "provides for a highly contextualized rich chronological understanding of a specific case" (p. 91). Bastian (1999) credits Wallace (1997) with inspiring her use of historical case study methodology as the method selected for *Defining Custody: The Impact of Archival Custody on the Relationship Between Communities and Their Historical Records in the Information Age—A Case Study of the United States Virgin Islands*.

H. DARWIN-RELATED DISSERTATIONS

Searching in a variety of databases and sources did not locate any HIB studies that previously investigated the information behaviors of Charles Darwin. However, several Darwin-related dissertation studies with information connections were found. Several of these dissertations, discussed below, utilize a case study approach.

Karanikas (1992) uses a case study methodology to study the metaphorical aspects of the scientific discourse of Charles Darwin, James D. Watson and Francis Crick, and Barbara McClintock. Categorized by subject headings of literature, philosophy, history of science, and rhetoric, Karanikas's research analyzes the "autobiographies, biographies, historical findings, popular accounts, and interviews where scientists narrate their experience of discovery" (p. 85). The study looks at "select passages from Darwin's works" and cites literary critic Gillian Beer's conclusions about the influence of literature like Shakespeare, Milton, and Wordsworth upon Darwin. Karanikas provides insights into Darwin's thought processes: his observations, experiments, "collaborat[ion] with specialists on details that he did not understand", "conversations with his colleagues over their unexpected interpretations of his collections", integration of "data and theoretical influence from different specialized disciplines", and even his mistakes, such as misclassifying Galapagos tortoises and mislabeling many Galapagos specimens (p. 86).

Karanikas cites famed evolutionary biologist Stephen Jay Gould's statement that even as an amateur researcher Darwin could "cut through older patterns of thought to glimpse new modes of explanation that might better fit an emerging detailed story constructed by experts who, somehow, could not take the big and final step" (p. 86). Karanikas's chief point regarding Darwin in this study is that his genius and "insight arose from the blurring of distinctions among specialties", evinced by Darwin's ability to recognize links across scientific disciplines and socio-economic theories (pp. 88, 89, 95).

Another study employing a case study approach is Keegan's (1985) *The Development of Charles Darwin's Thinking on Psychology (Creativity, Cognition, Evolution)*. This psychology-oriented dissertation incorporates an "evolving systems approach" to examine Darwin's thinking about how the mind functions and the evolution of human cognition (pp. 2-3). Keegan specifically uses a cognitive developmental case study method where "[t]he guiding premise [of this method]…is that the intensive study of an individual…yields valuable information about thinking that cannot be produced by other methods" (p. 2).

Keegan (1985) asserts that Darwin assimilated the scientific concept of "gradualism": "…the idea that a constant process of small change summed over long stretches of time could produce remarkable alterations" (p.69). Keegan's study of Darwin's assimilation of gradualism as a concept may not only shed light on how Darwin developed his theories but may also inform consideration as to whether and/or how Darwin's own cognitive processes changed throughout his life.

A strength of Keegan (1985) is that the study provides analysis of Darwin's notebooks, e.g. The B Notebook (p. 70), The C Notebook (p. 73), The M Notebook (p. 87), and thereby may yield insights into Darwin's information behaviors. Discussion of Darwin's Notebooks in these sections also includes reflection regarding Darwin's thinking about evolution and the mind. The Appendix provides Keegan's transcription of *Biographical Sketch of a Child*, a diary primarily kept by Charles Darwin, which recorded Darwin's observations on the development of his children (p. 217). This diary is another potential source for discerning Darwin's information organization and use.

Bell's (1989) dissertation, *Charles Darwin as a Laboratory Director*, analyzes the extant published and unpublished correspondence of Darwin and many with whom he corresponded, as well as books and papers written by Darwin and others. The study looks at Darwin's roles as "an experimentalist and as a laboratory director or head of a research program" whose local and global contacts enabled him to accomplish "a revolution by involving many others" in his pursuits (p. xi). Bell's dissertation is categorized as a history of science and a biography. The two major themes of the study are identified as Darwin's experimentation and his use of correspondence as knowledge-generating devices (p. 7). Bell's consideration of this latter theme of knowledge, in conjunction with knowledge's antecedent—information—and human information behaviors like information seeking, organization, and use are seen in Bell's principal finding and contention:

> Darwin is known as a compiler of information from world-wide sources, of information used primarily for The Origin of Species [and other works]…It was the information he compiled, even more than the theory for which he is famous, that swayed the world and convinced at least a good part of mankind that transmutation of organisms from one species to another had indeed occurred. (p. 1).

Bell investigates and emphasizes the importance of Darwin's hunting and gathering of "[a]n enormous number of 'facts' (observations) about many phenomena [that] had been accumulating in every branch of natural history for the previous 100 years" (p. 11), in addition to his collecting of facts or observed phenomena "gleaned from the extensive correspondence network he had built since his return from the *Beagle* voyage, and a large number discovered through his own scientific efforts" (pp. 11-12).

A potentially helpful feature of Bell's (1989) study is the list of tables and accompanying textual analysis regarding persons with whom Darwin corresponded, e.g. Table 4. Darwin's world-wide correspondence, 1861-1882, p. 514, (p. vi.). A more mixed section is found where Bell describes various aspects of Darwin's study and other rooms at Down House related to information organization, but unfortunately does so in scant detail and with little development: "One wall next to the fireplace was fitted with slots for bits of paper on a myriad of subjects. A table had room for experimental equipment and bottles of chemicals and there was a desk for writing" (p. 488). Figures such as an ordinary-looking black and white photo of one side of Darwin's study labeled "Figure 9. Darwin's study: shelves for filing data" add little to meaningful insight and could just as easily have been omitted, for lack of linkage to explanatory text on the relevance of such features. The most serious weakness of the study, however, is a paucity of explanation about the significance of the study and the methodology Bell employs in the research, jumping directly from an introduction of the study's issues to chapters reciting and analyzing instances about Darwin's experimentation and Darwin-related correspondence, and culminating with a concluding "Assessment" section and "Appendix."

Gale's (1980) dissertation, *After Malthus: Darwin Working on His Species Theory, 1838-1859*, is in the area of history of science. Ostensibly using an essay approach, Gale focuses on the period from 1838, when Darwin read Malthus's (1798/1933) *Essay on Population*, through the publication of Darwin's *The Origin of Species* in 1859. Some scholars suggest that by the time Darwin read Malthus's population essay, Darwin's evolutionary theory, though yet unpublished, was for the most part conceptually complete (pp. 2-3). Gale, however, suggests that 1838 can really be seen as a beginning point regarding Darwin's development of his theory (p. 6). Under this view, Darwin is portrayed as "ill-equipped in terms of knowledge and experience for tasks that lay ahead of him at the time" (p. 6).

One of Gale's (1980) strengths, thus, is the study's examination of Darwin's post-1838 development, which provides insight into his information behaviors and evidence pertaining to arguments about the evolution of his information behaviors. For example, Gale discusses aspects of Darwin's information seeking and use, asserting "how really dependent he was on the help of others for much of his work on species" (p. 6). Light is cast on Darwin's information organization and knowledge management as well, such as where Gale examines "how well developed organizational, management, and interpersonal skills and abilities helped him first secure and then benefit from this help" (p. 6). Gale views Darwin as a "scientist-manager par excellence" (p. 265) who "showed great skill at marshalling evidence, structuring arguments, using whatever facts, ideas, notions, hypotheses, analogies, etc. he could lay his hands on in order to bolster his case" (pp. 265-266). Implicit in that contention, clearly, are connections to questions about how Darwin sought, organized, and used information and knowledge throughout his life.

A weakness of Gale (1980), as with Bell (1989), is the dearth of explanation about the study's methodology. Gale fails to describe the research method(s) used and consequently provides no discussion of the strengths and weaknesses of the methodology. Limitations of the study are also not addressed. One may also suggest that a shortcoming of all the dissertations reviewed heretofore is the absence of any kind of models.

Kaye's (1996) dissertation, *Charles Darwin's Scientific Development: A Levinsonian Study of Early and Middle Adulthood,* uses a biographical method and the life-cycle approach developed by Levinson et al. The study is categorized within the areas of developmental psychology, biography, and history of science. Darwin was selected for research, Kaye explains, "…because there is a wealth of archival material with which to document his long life" and "abundant empirical data for a detailed reconstruction of [Darwin's] life" (p. 51).

Kaye (1996) provides analysis of data "drawn from published and unpublished correspondence and diaries, as well as Darwin's own published works" and in the vein of other studies discussed above is beneficial in collating a variety of data sources both requisite and relevant for an investigation of Darwin. Kaye explains the reasons why the biographical research method was chosen for the study as well as potential upshots of using this method, like hypothesis generation (p. 51) and identification of themes (p. 53).

A strength of Kaye's (1996) study is the forthright discussion about the research's limitations and strategies for mitigating those limitations:

> Any new studies of Darwin's life must address the unfortunate fact that prior to the ongoing publication of his complete correspondence, Darwin's letters and memorabilia had been subject to widespread censorship and bowdlerization, errors of omission and transcription, and apocryphal report. (p. 56).

Kaye, therefore, "examined early biographical writings on Darwin with care, due to the distortions of this decades-long censorship [by Darwin family members]" (p. 57). In addition, Kaye looked at "other published primary source materials, including the published works of Darwin himself" and notes that research on Darwin has been enhanced by "the recent availability of important documentary evidence" (p. 57).

The argument can be made that another strength of Kaye's (1996) study is its longitudinal focus, scrutinizing Darwin's life from beginning to end, toward Kaye's stated aim of "understanding the tasks of a given period of the life cycle [which] can enhance our understanding of the individual life course". Studies like Kaye's (1996) may facilitate greater understanding of the holistic and longitudinal behaviors of individuals like Darwin.

I. DARWIN-RELATED BOOKS

A number of Darwin-related books were used during this dissertation. A few were used significantly during the dissertation's proposal preparation and cited in earlier sections: these were (1) Browne's (1995) *Charles Darwin: Voyaging*, the first volume of her two-volume Darwin biography, and (2) Desmond and Moore's (1991) classic Darwin biography, *Darwin: The Life of a Tormented Evolutionist*. Both resources are considered landmark, authoritatively researched works on Darwin. Both are also very engaging and readable works that adeptly present richly detailed and cited information about their subject, but also balance this by placing Darwin within broad historical and social contexts. Browne (1995, 2002) and Desmond and

Moore (1991) are cited frequently in other resources pertaining to Darwin. These books were featured prominently in the Down House book section examined in March 2006, as well as the book section of the American Museum of Natural History's Darwin exhibition, which was visited in December 2005.

Browne (1995) and Desmond and Moore (1991) were used extensively during the post-proposal defense stage of the dissertation as well. In addition, Browne's (2002) second volume, *Charles Darwin: The Power of Place*, was a beneficial resource. Browne's (1995, 2002) volumes and Desmond and Moore's (1991) biography were especially insightful with regard to the Darwin/Wallace case study, discussed in detail below.

Di Gregorio's (1990) *Charles Darwin's Marginalia* is a very useful Darwin scholarly resource, which transcribes, edits, explains, and within a larger context insightfully frames Darwin's numerous annotated references, which he wrote inside of and upon the books, articles, etc., that he owned, borrowed, loaned, and used. This resource was first used while performing research at Cambridge University in March 2006, and again was used later in the U.S. It was beneficial for describing several of Darwin's information behaviors, which are discussed below.

Armstrong's (1985) *Charles Darwin in Western Australia: A Young Scientist's Perception of an Environment* focuses specifically on Darwin's brief time there during the *Beagle* voyage. However, it provides useful information regarding Darwin's general collecting, observing, and recording practices. Some informative black and white images of Darwin's notes are included, which offer insights into Darwin's recording, scoring, annotating, etc., behaviors. Armstrong (1985) also presents an interesting graphic model depicting how different print sources, e.g. Darwin's diaries, field notes and note books, notes, and print materials on the *Beagle*, constituted a "'flow' of ideas", contributing to their compilation in various Darwin publications, such as *Origin* (1859) (p. 9).

Another source related to Darwin's brief *Beagle* forays in Australia is Nicholas and Nicholas's (2002) *Charles Darwin in Australia*. It discusses Darwin's diary and notebook entries related to his expeditions in Australia. A selection of photographs of Australian flora and fauna, and copies of some of the *Beagle*'s Australia-related documents and sketches is provided. In addition, several sketches of the *Beagle* crew having connections with Australia, such as Darwin's servant/assistant Syms Covington who emigrated there a few years after the voyage, and an informative postscript discussing some of these *Beagle* crew members, are included too.

Barrett et al.'s (1987) *Charles Darwin's Notebooks, 1836-1844: Geology, Transmutation of Species, Metaphysical Enquiries* presents more than 600 pages of editorial explanation and transcription of many of Darwin's notebooks, such as the famous Red Notebook. Darwin's Red Notebook is unique among the notebooks, as it was written during the final part of the *Beagle* voyage and completed post-voyage. It is also the first place where Darwin recorded his transmutation ideas. This source discusses the Questions & Experiments Notebook, which is discussed below. In addition to providing notebook transcriptions, each notebook's discussion includes physical and provenance descriptions and a general description of the contents. Some interesting images are included, such as notebook pages, which are described below. This book is likely the most comprehensive resource on the actual content of Darwin's notebooks and is an authoritative resource for Darwin research.

One of the editors of Barrett et al. (1987) is Herbert (1980), who edited *The Red Notebook of Charles Darwin*. As its name implies, it focuses exclusively on the transcribed contents of Darwin's Red Notebook. Photos of some of the notebook's pages and sketches are included. Several models regarding the Red Notebook as well as a chronological model of eight notebooks, in which Darwin recorded from 1836-1839, are presented. Another of her books, Herbert's (2005) *Charles Darwin: Geologist*, looks at Darwin's geological notebooks, specimens and work, within the broad framework of 19th century geology. This book is authoritative and copiously referenced, and it provided a number of useful instances of Darwin's information behaviors, which are cited in this dissertation.

Quammen's (2006) *The Reluctant Mr. Darwin: An Intimate Portrait of Charles Darwin and the Making of His Theory of Evolution* has received a good deal of press and very favorable reviews in the mainstream press, such as *The New York Times Book Review*. It is an excellent example of the genre referred to as "scholarly journalism": highly readable, detailed, engagingly anecdotal and historical, concise, and well-organized. Quammen chooses to pick up Darwin's story after the *Beagle* voyage has ended in 1836, but also includes informative pre-1837 references, as needed and pertinent. Although not cited significantly in this dissertation, this book was very useful for providing an overview of Darwin's life and his work. It was also very beneficial in explaining and framing the Darwin/Wallace crisis of 1858, which will be examined further in the case study below.

Eldredge's (2005) *Darwin: Discovering the Tree of Life* is a companion book to the traveling Darwin exhibition, which resided at New York's American Museum of Natural History from November 2005-May 2006. Eldredge is the curator of the museum. He worked closely with English Heritage's Down House curator, Ms. Tori Reeve, who facilitated this dissertation's private visit to Down House in March 2006 for research purposes, in recreating Darwin's famous Down House study for the exhibition. This book is a very worthwhile mix of enlightening text by the author and a plethora of stunning color images representing all areas of Darwin's personal and professional life, as well as excellent pictures of his hand-written notes and notebooks. It also contains a sketch of his famed evolutionary tree and various diagrams and models created by researchers.

A few other Darwin-related books were skimmed during this dissertation. Richard Darwin Keynes is Darwin's great-grandson and a former professor of physiology at Cambridge University. He has written a number of other books on the subject of his great-grandfather, some focusing on personal, familial insights into Darwin and some examining Darwin's scientific pursuits. Keynes was also involved significantly in the currently ongoing traveling Darwin exhibition. Keynes's (2003a) *Fossils, Finches and Fuegians: Darwin's Adventures and Discoveries on the Beagle*, focuses on that period in Darwin's life. It provides an array of interesting images, sketches, maps, etc., in color and black and white. Haupt's (2006) *Pilgrim on the Great Bird Continent: The Importance of Everything and Other Lessons from Darwin's*

Lost Notebooks, like Quammen (2006) described earlier, received favorable reviews and is an engaging book. It focuses on Darwin's ornithological notes and provides some interesting background on Darwin's life.

J. DARWIN-RELATED JOURNAL ARTICLES

Various Darwin-related journal articles from diverse research disciplines are pertinent to an information-oriented dissertation study of Darwin. Many of these articles derive from study of Darwin's famed notebooks, such as those kept during the 1831-1836 *Beagle* exploration. Schweber (1977), in part discusses the variety of items Darwin read which contributed to his conceptual breakthrough in natural history. Vorzimmer (1977) describes the reading notebooks that Darwin maintained, listing and annotating the books he had read and those that he planned to read; he provides a transcribed chronological listing of the books that Darwin read. Notations in Darwin's notebooks indicate that his natural selection model was influenced by decades of mental accretion from the ideas and writings of other researchers, as reported by Richardson (1981).

Butcher (1989) inspects the approaches by which Darwin utilized scientific information that originated in Australia, such as observations recorded in his *Transmutation Notebooks* during the *Beagle* voyage's stop in Australia. Kottler (1978) shows how Darwin developed his theory of geographic speciation in his *Transmutation Notebooks*. Kohn, D., Smith, S., & Stauffer, R. (1982) investigate Darwin's "unorthodox note-taking and research methods", such as using notebooks from 1837-1839 but keeping loose notes in portfolios after 1842, which they state "make it very difficult to trace the development of Darwin's thinking". Keynes (2003b) underscores "the systematic organization of Darwin's notes", such as his zoological notes, specimen lists, and other notebooks and writings from the *Beagle* odyssey, and how that systematic organization "contributed greatly to his success".

The late LIS indexing, documentation, classification, and library history researcher and Western Reserve University's Baxter School of Information and Library Science Dean Emeritus Jesse Shera (1964) discusses the influence of Darwin and Sir Francis Bacon on librarianship research. Darwin's influence on the classification systems developed by Dewey, Cutter, and others is also briefly mentioned in Shera's (1965) book, *Libraries and the Organization of Knowledge*.

Several additional Darwin-related articles were found during this dissertation. Veak's (2003) study was cited in the rationale section above. He posits that a wealth of untapped information remains to be uncovered in Darwin's extant correspondence. He finds that many of Darwin's most significant sources and projects have not been studied. Sheets-Pyenson (1981) studies how Darwin read and used natural history journals from 1837-1842. She describes his annotating of each journal, how the journals impacted his thinking and writings, and how he incorporated information from the journals into his later works. Lennox's (2005) article, "Darwin's Methodological Evolution", examines whether Darwin can be seen as an innovator and asserts that if he can be seen as such, it is as a philosopher and methodologist. Gopnik (2006), in a *New Yorker* article called "Rewriting Nature", examines Darwin's strategy for writing and "selling" the radical ideas in *Origin*, calling it is one of the great successes in rhetoric. He asserts that Darwin's writing style is more akin to a Victorian novelist than a Victorian sage, which also contributed to its success.

K. INFORMATION-RELATED STUDIES OF EXPLORERS

Perhaps the period of Darwin's life offering the most and/or best evidence of his information behaviors is the 5-year span in which he was a natural history scientist/explorer during the 1831-1836 *Beagle* expedition. A number of studies focus on or involve aspects related to the information behaviors of explorers. Some of these studies do not specifically employ HIB terms like "information behavior" or "information needs and uses." Nevertheless, such studies are relevant to HIB studies because they share connections with information-encompassing behavior and information-oriented contexts.

Stam and Stam's (2002) book, *Books on Ice: British & American Literature of Polar Exploration*, looks at the "reading" available to and/or used by polar explorers to probe "the mental life of those venturers—clues to what they thought they were doing, to why they were doing it, and to what accounted for their successes." The researchers acknowledge that lists of explorers' books or work tables alone cannot definitively explain "what might be in their heads." But expedition diaries and accounts *can* provide articulated written indicia of information behaviors from the subjective perspective of the chronicler himself.

In addition to Bibles, fiction books, and newspapers, Stam and Stam (2002) point out that many polar explorers had access to technical books and exploration histories which comprised the bulk of expedition libraries. Instances of information seeking and use of such resources are seen in a polar explorer's recounting of the second Scott expedition:

> [A library of Arctic and Antarctic travel books] were used extensively in discussions or lectures on such polar subjects as clothing, food rations, and the building of igloos, while we were constantly referring to them on specific points and getting useful hints such as the use of an inner lining to our tents, and the mechanism of a blubber stove.

Stam and Stam's (2002) study is useful as an exploratory overview of explorers' "accounts…of what was read and why, and how and where, and what those isolated readers thought of their reading experience." The research methods and data collection strategy used denote the types of data and findings which this type of research can yield.

Thomas's (2003) *Cook: The Extraordinary Voyages of Captain James Cook* discusses reading by the men on board the *Endeavour* during Cook's epic journey around the globe:

> [The *Endeavour*'s] men were not simply searching and seeing, but also *reading*. Voyaging was, for officers and scientists, a surprisingly bookish business. Off duty, if one could read, there was not much else to do, and lieutenants and midshipmen passed around copies of books like *Tom Jones*. (p. 43).

Thomas also describes the specific use by botanist Joseph Banks of information from various books from the *Endeavour*'s library:

> In the course of writing his journal of the passage south, from England to Madeira, past Tenerife and to Rio, [Banks] cites a

> veritable library. A rare fish is known from Sir Hans Sloane's *Voyage to Jamaica*; a bonito carries a parasite depicted in the Dutch scholar Baster's *Opuscula Subseciva*; he 'shot the black toed gull of *Penn. Zool.*', that of his acquaintance Thomas Pennant's *British Zoology*, published two years earlier. For one reason or another, he alludes to Willem Edward's *Natural History of Birds* and Brisson's *Ornithologie*. (p. 43).

Cook's use of books for information is also related by Thomas:

> For his part Cook consulted manuscript copies of the logs of Byron and Wallis and works such as Anson's *Voyage Round the World*. The authors of this narrative happened to recommend Rio as a place for refreshment: 'any quantity of hogs and poultry may be procured', and Cook very likely had this advice in mind when he chose to call there before negotiating the notoriously difficult passage around the bottom tip of South America. (p. 43).

In addition to the importance of books as information sources, Thomas notes that Maoris encountered by the *Endeavour* were an information source as well, manifested by their generosity in providing information to the explorers far from home (p. 109).

L. ADDITIONAL STUDIES FOR POTENTIAL REVIEW AND CONSIDERATION

Several other potential study areas were identified in the proposal and are included in this dissertation too, as they may be beneficial to review and consider for future research. The history of botanical and medical scientific illustration may provide useful insights into Darwin's exposure to the research aspects of illustration, which he may have gained through his educational and exploratory experiences and interaction with professors and fellow researchers. Awareness of such illustrations may have influenced Darwin to sketch and use his own botanical and geological illustrations and those of others, such as his grandfather, Erasmus Darwin. Illustrations, such as those recorded in Darwin's *Beagle* voyage geological notebooks, can be seen as involving aspects of information gathering, organizing, and use behaviors.

It may also be informative to look at library histories of the University of Edinburgh and the University of Cambridge, which Darwin attended, to ascertain whether and if so how the respective library collections, organization and classification systems, etc. of those academic institutions may have influenced Darwin to seek, organize, and use information. Index examination of McKitterick's (1986) *Cambridge University Library, A History: The Eighteenth and Nineteenth Centuries* reveals only one mention of Darwin, regarding Cambridge's award of an honorary degree, but provides potentially instructive discussion about Cambridge's library shelving and organization methods during his lifetime. Such insights may, as example, shed light on how Darwin was influenced to organize his burgeoning collected information via the magazine portfolios and subject grouped book collections he maintained at Down House.

IV. RESEARCH DESIGN

A. RESEARCH METHODS: INTRODUCTION

The research questions in this dissertation, e.g. "What were the information behaviors of Charles Darwin?", and more specifically, "What were Charles Darwin's information needs and how did Charles Darwin seek, organize, and use information?", were examined through historical case study methodology. This method is a hybrid of historical research methods and the case study methodological approach. Additionally, grounded theory was incorporated throughout this dissertation to investigate insights and findings, anticipated and unanticipated, which emerged from the data during the data collection and analysis stages. Grounded theory was employed because it is a useful means for developing models (Ellis, 1989, 1993). Determining whether it would be possible to develop a model of Darwin's information behaviors was a research question and objective of this dissertation.

1. Multiple methods introduction

It is well-established in scientific research that researchers should always use at least two methods when studying social science phenomena. The rationale for this is to reduce the possibility of misleading results, which reliance on only one method can produce (Campbell & Fiske, 1959). Selecting the research method or data collection strategy for conducting an HIB study is one of the most important decisions a researcher must make. As Yin (2003) underscores: "Each strategy has peculiar advantages and disadvantages, depending on three conditions: (a) the type of research question, (b) the control the investigator has over actual behavioral events, and (c) the focus on contemporary as opposed to historical phenomena" (p. 1). Multiple methods will be examined in more detail later in this section.

2. Summary of research methodology design

Combining the historical research and case study methodologies in this study was used to contribute to maximization of the advantages of each approach and mitigation of their respective weaknesses. Utilizing grounded theory to analyze the data provided useful insights and findings that suggested explanations for the research questions. Such explanations can in turn promote potential model and theory building. A multiple methods approach was employed to facilitate the reduction of potentially misleading or erroneous results. The next sub-sections of this Research Design discussion will address the respective research methodologies used in this dissertation.

3. Historical method (also referred to as historiography):

a. Historical method features Berg (2004) provides a helpful definition for historical research: "Historical research attempts to systematically recapture the complex nuances, the people, meanings, events, and even ideas of the past that have influenced and shaped the present" (pp. 233-234). Berg stresses though, that historiography involves much more "than the mere retelling of facts from the past…[and]…is more than linking together old pieces of information found in diaries, letters, or other documents, important as such an activity might be" (p. 233). Historical research should possess and exude research rigor (p. 233). Historical methods focus on interpreting evidence from the past and examining surviving "traces" of past human behavior (Case, 2002, p. 207). Yin (2003) explains:

> The distinctive contribution of the historical method is in dealing with the "dead" past—that is, when no relevant persons are alive to report, even retrospectively, what occurred and when an investigator must rely on primary documents, secondary documents, and cultural and physical artifacts as the main sources of evidence (p. 7).

b. Interpretation of data: reasons for doing historical research The principal incentive for conducting historical research, similar to the rationale for data collection strategies, is to collect information and interpret or analyze that data (Berg, 2004, p. 235). Berg states that historical research is performed for one or more reasons, such as:

- To uncover the unknown;
- To answer questions;

- To seek implications or relationships of events from the past and their connections with the present;

- To assess past activities and accomplishments of individuals, agencies, or institutions; and

- To aid generally in our understanding of human culture (p. 235).

c. History The essence of historical research is, of course, history. So it may be beneficial to briefly consider what "history" is and is not. "History" is *not* a tangible object waiting to be discovered. As Howell and Prevenier (2001) underscore in *From Reliable Sources: An Introduction to Historical Methods*, "history has no existence before it is written" (p. 1). History is by its very nature subjective to a great extent:

> [H]istory is: the stories we tell about our prior selves or that others tell about us. In writing these stories, however, historians do not discover a past as much as they create it; they choose the events and people that they think constitute the past, and they decide what about them is important to know. (Howell & Prevenier, 2001, p. 1).

Historian A.J.P. Taylor intones that "History is not another name for the past, as many people imply. It is the name for stories about the past."

d. Role of sources If history *is* stories about the past, from what and where then do these stories originate? Sources are the key. Namely, history derives from sources that historical researchers "use to interpret the past" and "with which [they] build meanings" (Howell &

Prevenier, 2001, p. 1). Hence, issues related to the selection of sources are vitally relevant to historical research:

> It is no wonder then that at least since the nineteenth century, when history writing was firmly located in the academy and professionalized, when it became what some call "scientific," historians have paid careful attention to how sources are chosen and interpreted. They have developed sophisticated techniques for judging a source's authenticity, its representativeness, and its relevance. (Howell & Prevenier, 2001, p. 1).

e. Pitfalls of historical research methodology Howell and Prevenier (2001) point out a number of pitfalls that may befall historians. One potential problem is the imposition of modern thoughts when looking at information from and about the past (Berg, 2004, pp. 235-236). Historical method researchers must also use due diligence to ensure the veracity and authenticity of historical materials. Such efforts help to ensure the avoidance of historical hoaxes and frauds, like the hoax perpetrated on the German magazine *Stern* when it bought the so-called "Hitler diaries" which were eventually exposed as forgeries (pp. 240-242).

f. Other concerns about historical methods Looking further at some of the potential weaknesses in using historical methods, several other questions arise. For example, how can researchers know with certainty that the accounts they are analyzing, which may be in the form of autobiographies, diaries, logs, notebooks, personal letters, and family Bible records, are in fact accurate recordings of what actually transpired? As Krathwohl (1998) states, "A document may be genuine in that it was produced at the time and by the person presumed to have produced it but still be an inaccurate account of what is of interest" (p. 578). What enables researchers, as a specific example, to rely with a high degree of assurance upon

Charles Darwin's self-reported statement in his autobiography about the indexes he claims that he created? (Barlow, 1958, pp. 137-138; Spink & Currier, 2006a; 2006b).

g. Corroboration and validation of evidence Answers to the legitimate concerns and potential shortcomings of historical methodologies, discussed above, are complex. Factors such as the reputations of the subject of inquiry and the researcher(s), the quantity and quality of material available, the foundation of already-completed scholarly interpretation of the subject's life and work, and so forth must be weighed and substantiated in evaluating the reliability and validity of a source. As with any research study, selective interpretation (Krathwohl, 1998, p. 573) and the existence of rival explanations (p. 579) are also factors that may complicate the validity and reliability of a historical study. Answering important questions such as whether there are other sources of material, surviving artifacts, accounts from other persons, etc. that can bolster the interpreted meaning of someone's claim or another source may be determinative in validating or invalidating historical accounts and sources.

h. Darwin (Barlow, 1958) example revisited Returning to the Darwin indexing example mentioned earlier, researchers may be able to corroborate or validate Darwin's own account of the indexes he created in a number of ways. One way is to look for surviving indexes that Darwin may have created. Another way is to search other writings of Darwin's for corroborating evidence of his indexes. Searching sources other than Darwin's may also produce evidence of his indexes. In support of this point, Darwin's son, Francis, discusses his father's indexes in an edited 1959 collection of Darwin's letters. Additional corroborative possibilities include first-hand visits to and inspection of places that Darwin physically inhabited, e.g. his country home, Down House, in Downe, Kent, England, where he lived and worked for much of his adult life, or where Darwin materials are housed and accessible, such as the extensive Darwin collections preserved at Cambridge University and the American Philosophical Society Library in Philadelphia, Pennsylvania, U.S.A.

4. Case study method

Case (2002) explains that the rationale for the case study method derives from the legal profession where "the main unit of analysis is the single instance" (Case, 2002, p. 178). Krathwohl (1998) adds to Case's history of the case study methodology, elucidating that "[c]ase studies have their origins in the medical and legal profession where, vividly and precisely conveying the characteristics of a single individual, situation, or problem, they are used to illuminate a generic problem" (p. 332). Certainly one of the best-known users of the case study method is Freud, who used it extensively in his early psychopathology research (Case, 2002, p. 178). In addition, "…the case study has been a common research strategy in psychology, sociology, political science, social work (Gilgun, 1994), business (Ghauri & Gronhaug, 2002), and community planning" (Yin, 2003, p. 1).

a. Single entities, comparison, and context Many case studies focus on single entities: an individual, an organization, or a country (Case, 2002, p. 179). However, some case studies may also investigate several individual cases in order to compare results (Case, 2002, p. 179). Case study method emphasizes the context of the unit investigated, such as a person within his or her own social milieu (Case, 2002, p. 179). Krathwohl (1998) outlines some important aspects of the case study method:

> Case studies are bounded by a particular individual, situation, program, institution, time period, or set of events. Within those boundaries, whatever is the focus of attention is described within the perspective of the context surrounding it. Case studies are ideal for illustrating the complexity of causation. The case study is sometimes a step in a larger study where cases are combined in support of an overall explanation or theory that arises out of cross-site analysis. In many instances, the time-bound nature of the material results in a time-line type of narration that organizes the presentation of a qualitative study (p. 332).

It is particularly important to note that case studies can include any combination of quantitative or qualitative methods alone or together with regard to data collection (Denzin & Lincoln, 2000; Yin, 2003, p.14). Huberman and Miles (2002) support this as well and also set out some objectives for utilizing case study, stating that "Case studies typically combine data collection methods such as archives, interviews, questionnaires, and observations…and case studies can be used to…provide description…, test theory…, or generate theory" (p. 9).

b. Understanding of social phenomena and holistic aspects of real-life events Yin (2003) is considered to be an authority on case study methodology and provides some further insights. He emphasizes the case study's ability to facilitate understanding of complex social phenomena and provide holistic insights of events (p. 2). Case study method, as example, allows researchers to examine events or periods such as individual life cycles (p. 2). Yin notes that, "As a research strategy, the case study is used in many situations to contribute to our knowledge of individual, group, organizational, social, political, and related phenomena" (p. 1).

c. Examples of exploratory, descriptive, and explanatory case studies Case studies can be of three varieties: exploratory, descriptive, or explanatory (Yin, 2003, p. 3). Wilford's (1992) analysis of Christopher Columbus's 15th century New World exploration is an example of an exploratory case study (Yin, 2003, p. 23). Yin (2003) offers Allison's (1999) 2nd edition of *Essence of Decision: Explaining the Cuban Missile Crisis* as an example of an explanatory case study, and Whyte's (1943/1955) *Street Corner Society*, describing life in an Italian-American neighborhood, as a classic example of a descriptive case study (pp. 3-4).

d. Objections to case study methods All research methods have strengths and weaknesses and Yin (2003) discusses several concerns about case study methods (p. 10). One concern is a lack of rigor used in some case studies. To mitigate this, he stresses the importance of avoiding sloppy work, following systematic procedures, and not allowing equivocal evidence or biased viewpoints to unduly influence the researcher's findings and conclusions (p. 10). Yin also discusses concerns about whether case studies are generalizable, noting that the response is complex (p. 10). The short answer, he suggests, is "that case studies, like experiments, are generalizable to theoretical propositions and not to populations or universes" (p. 10). He underscores that the researcher's aim is to conduct "a 'generalizing' and not a 'particularizing' analysis" (pp. 10-11).

e. Distinguishing case studies and historical methods The use of case studies is sometimes confused with historical methodologies. Yin (2003) explains the difference:

> The case study method is preferred in examining contemporary events, but when the relevant behaviors cannot be manipulated. The case study relies on many of the same techniques as a

> history, but it adds two sources of evidence not usually included in the historian's repertoire: direct observation of the events being studied and interviews of the persons involved in the events. Again, although case studies and histories can overlap, the case study's unique strength is its ability to deal with a full variety of evidence—documents, artifacts, interviews, and observations—beyond what might be available in a conventional historical study. (pp. 7-8).

Hence, the case study method is well-suited to accommodate a multiple methods research approach or operate as a single research methodology.

5. Grounded theory

Grounded theory is a qualitative research method focused on theory generation (Gay & Airasian, 2003; Krathwohl, 1998). Gay and Airasian (2003) describe grounded theory's objective as "generating a theory that explains, at a conceptual level, a process, an action, or a concept" (p. 167). Grounded theory is particularly warranted when trying to understand a topic or situation (p. 167). "That is, the researcher asks, "What is happening in this situation and how can I provide a theory to explain it?"" (p. 167). Grounded theory employs a "constant comparison method" where data is collected numerous times and compared and integrated with previous findings (p. 167). Through this constant comparison method, Krathwohl (1998) explains, "we gradually develop an understanding of the phenomenon and a theory, or explanation, of how the phenomena are grounded in our observations—that is, we have what Glaser and Strauss (1967) termed "grounded theory"" (p. 260). An important element for understanding stress about grounded theory is the often emergent nature of this method. Namely, new thinking and/or unexpected insights may come to light as the study progresses and the data is analyzed. This may occur because sometimes, for example, the researcher discovers additional promising sources and decides to pursue a different course of action during the study. As Gay and Airasian (2003) state, this can happen because "the researcher probably won't know at the beginning what literature will later turn out to be relevant" (Gay & Airasian, 2003, p. 168).

6. Multiple methods

A multiple methods approach is the use of more than one research methodology or data collection strategy (Krathwohl, 1998, pp. 618-619). Multiple methods offer the potential for strengthening a study by enhancing its validity and reliability. This strengthening occurs through *triangulation*, which will be discussed in more detail below. Krathwohl (1998) cites Brewer and Hunter (1989), who summarize the major advantage of a multiple methods approach: "Our individual methods may be flawed, but fortunately the flaws are not identical. A diversity of imperfection allows us to combine methods not only to gain their individual strengths but also to compensate for their particular faults and limitations" (pp. 16-17).

a. Advantages of multiple methods:

i. Reduction in "inappropriate uncertainty" A multiple methods approach offers some substantial potential advantages (Campbell and Fiske, 1959). One upshot of using multiple methods is in reducing "inappropriate uncertainty" (Robson, 2002). Robson explains that "Using a single method and finding a pretty clear-cut result may delude investigators into believing that they have found the 'right' answer. Using other, additional, methods may point to differing answers which remove specious uncertainty" (p. 370).

ii. Triangulation Triangulation is the most significant strength that can potentially be gained by using a multiple methods approach. Robson (2002) describes its etymology and applicability:

> Triangulation, in surveying, is a method of finding out where something is by getting a 'fix' on it from two or more places. Analogously, Denzin (1978) suggested that this might be done in social research by using multiple and different *sources* (e.g. informants), *methods*, *investigators* or *theories* (p. 371).

In short, triangulation strengthens a study by combining methods. This can entail using several kinds of methods or data, including using both quantitative and qualitative approaches (Patton, 2002, p. 247). Patton (2002) clarifies a frequent misconception of triangulation:

> A common misunderstanding about triangulation is that the point is to demonstrate that different data sources or inquiry approaches yield essentially the same result. But the point is really to *test for* such consistency…Thus, understanding inconsistencies in findings across different kinds of data can be illuminative. Finding such inconsistencies ought not be viewed as weakening the credibility of results, but rather as offering opportunities for deeper insight into the relationships between inquiry approach and the phenomenon under study. (p. 248).

iii. Downsides to triangulation Two disadvantages of triangulation are time and money. Multiple methods almost always increase the amount of time necessary for conducting such research (Robson, 2002). Patton (2002) states that triangulation can be an expensive research ideal (p. 247). But expense can be mitigated by using triangulation "reasonably and practically" (p. 247).

7. Historical case study methodology

In considering the research methodologies that are most applicable to and advantageous for studying Darwin's information behaviors, the historical method and case study method offer some crucial strengths, for reasons discussed previously. An amalgamated research methodology referred to as "historical case study" combines historical research methods and case study methods.

Wallace's (1997) dissertation study of a specific case pertaining to federal information policy describes the rationale for selecting historical case study as his method:

> Historical case study research provides for a highly contextualized rich chronological understanding of a specific case. The historical method assists the case study by enabling it to be evaluated across time, and the case study aids historical analysis by narrowly focusing attention upon a discrete identifiable domain. (pp. 91-92).

Bastian (1999) also employs a historical case study approach in her dissertation examining historical records of the U.S. Virgin Islands. As Bastian (1999) explains, this method enabled her to focus on a distinct case, i.e. archival records of the Virgin Islands before purchase by the U.S. from Denmark in 1917, while placing the case in a historical context. Other examples of historical case study include research about the Federal Bureau of Investigation and discrete episodes from presidential administrations (Wallace, 1997, p. 92). "The prime advantage of the case study approach is that it can provide rich contextual explanation of specific events that are otherwise lost in more broad-based research" (Wallace, 1997, p. 22).

Combining the historical method and case study method into a historical case study method offers a multiple methods approach for this study, which may potentially draw upon case study's and historical research's individual strengths and diminish their weaknesses. Hence, a historical case study method will be used for this study.

8. Summary of research methods design:

This dissertation used a multiple methods approach comprising (1) historical case study methodology, and (2) grounded theory. Combining historical methodology with case study promoted several objectives for this dissertation. Firstly, using a historical methodological approach provided a chronological framework and context for examining Darwin's information behaviors. Employing a case study methodological approach enabled a focused investigation of specific Darwin-related sources for evidence of his information behaviors. Research inquiry concentrated on specific periods in Darwin's life, such as the 1831-1836 *Beagle* expedition. Patterns emerged from analysis of the data. Similarly, grounded theory was used to analyze and reanalyze data at varied times during the collection and analysis stages to compare and contrast the data, revisit and reevaluate expectations or suppositions from earlier in the study, identify potential patterns, and determine whether explanations of concepts, processes, or actions were emerging or emerged from the data later.

B. DATA COLLECTION

1. Introduction

This study examined a variety of primary and secondary source materials. Primary sources are "original material and eyewitness testimony which has not been subject to interpretation by other historians" (McDowell, 2002, p. 93). Official papers, diaries, letters, minutes, memoranda and taped interviews are all types of primary source materials (p. 93). Secondary sources are materials that "consist of the interpretations of other researchers on the content of the primary sources" (p. 93). Examples of secondary sources include books, pamphlets, handbooks, encyclopedias, and articles (Krathwohl, 1998, p. 105; McDowell, 2002, p. 93).

Primary and secondary source materials are important components of both historical research and case study methodology. In *From Reliable Sources: An Introduction to Historical Methods* Howell and Prevenier (2001) explain the significance of not only source identification and selection but also the comparing and contrasting of sources:

> Typically, historians do not rely on just one source to study an event or a historical process, but on many, and they contrast their own interpretations about the past by means of comparison among sources—by sifting information contained in many sources, by listening to many voices. Sometimes the information they have from various sources is contradictory, sometimes mutually confirming, but the historian's job in any case is to decide which accounts he or she will use, and why. (p. 69).

2. Converging lines of inquiry

Yin's (2003) *Case Study Research: Design and Methods* describes the rationale for using multiple evidentiary sources (p. 97). Yin also emphasizes the relevance of documentation—"one of the key categories of primary source material" (McDowell, 2002, p. 111)—for virtually all case study topics (Yin, 2003, p. 85). Yin cautions that "no single source has a complete advantage over all the others" and adds that, "In fact, the various sources are highly complementary, and a good case study will therefore want to use as many sources as possible" (p. 85). One reason for using multiple sources in case studies is to facilitate the ability of researchers "to address a broader range of historical, attitudinal, and behavioral issues" (p. 98). The most important advantage of utilizing multiple sources, though, is "the development of *converging lines of inquiry*, a process of triangulation" that enables a finding or suggested explanation "to be much more convincing and accurate if it is based on several different sources of information" (p. 98).

To promote triangulation and the development of converging lines of inquiry this study examined a wide range and number of sources. These sources were identified and organized in several appendices below. The availability of these sources was also annotated. Given the emergent nature of the qualitative research for this dissertation, additional sources were identified and investigated during the course of the research as they became known.

This study was of an exploratory nature, as it investigated Darwin's information behaviors without the precedent of a previous comprehensive study of his information behaviors. Grounded theory was used to capture emerging insights and respond accordingly. This dissertation's proposal did not delineate specific historical periods of Darwin's life for research emphasis before the study formally commenced. It was hypothesized that some periods in Darwin's life, such as the 1831-1836 *Beagle* voyage, might be fruitful in terms of providing data on Darwin's information needs and behaviors. Historical evidence indicated that Darwin extensively collected and recorded information while in the field or later, back on board the *Beagle*, in a plethora of notebooks, and that he subsequently mined those notebooks for information later, which he used in writing *Origin*. Raby (1996) notes that, "The collection and the ideas [Darwin] derived from his long field trip into the natural South American laboratory provided him with material for the rest of his life" (pp. 20-21). It was also posited that other pre- and post-*Beagle* periods of Darwin's life might similarly produce useful data bearing on Darwin's information behaviors. Therefore, during the data collection and analysis phases of this study, a flexible "wide net" strategy was used. As the study progressed and initial data was analyzed, determinations were made as to whether the study's focus should be narrowed to specific life periods or broadened to encompass Darwin's entire lifetime.

a. Primary sources A list of identified primary sources, many of which were examined during this dissertation, is provided below. Primary source and secondary source materials that were attainable by the most easily accessible means, e.g. via the University of Pittsburgh library system, are so notated, even though they may have also been available by less accessible means, e.g. housed at Cambridge. Primary sources that were considered and/or used in this dissertation research include the following:

i. Handlists, calendars of correspondence, concordances, etc. regarding Charles Darwin: some concordances are available via University of Pittsburgh libraries (hereinafter ULS) or interlibrary loan (ILL). A *Calendar of the Correspondence of Charles Darwin, 1821-1882, with Supplement* (1994) is available online via University of Cambridge Library (see Appendix D). A *Handlist of Darwin Papers at the University Library, Cambridge* (1960), *Supplementary Handlist of the Papers of Charles Darwin*, and catalogs to Darwin papers and various related family collections are non-borrowable but available for reading in the Manuscripts Reading Room and/or the Rare Books Room.

ii. Published books authored by Charles Darwin: most are available via ULS or ILL. Some are in the Cambridge collections and were examined while there in March 2006.

iii. Scientific and non-scientific articles and papers produced by Charles Darwin: many are available online; a significant number of Darwin's papers are available in full-text electronically and are keyword searchable via various databases and websites.

iv. Diaries kept by Charles Darwin: some diaries are transcribed and available in print; others are owned by Cambridge.

v. Notebooks written by Charles Darwin: some notebooks are transcribed and available in print; others are yet-to-be-transcribed and published by Cambridge.

vi. Letters composed by Charles Darwin: fifteen volumes of a projected 30-volume set of *The Correspondence of Charles Darwin* have currently been transcribed and published by the University of Cambridge, covering the years 1821-1867. Volume 15, the most recent, was published in 2005. The published 15 volumes are available in print via ULS and ILL. Volumes 1-6 will be available soon for online searching via Cambridge University Library. *Charles Darwin's Letters: A Selection, 1825-1859* (1998) is a volume of selected correspondence that has been compiled from the first seven volumes of *The Correspondence of Charles Darwin*. All known letters written by or to Darwin from 1858-1859, surrounding the publication of *The Origin of Species*, have been transcribed by Cambridge and are available online. The American Philosophical Society (APS) Library in Philadelphia, PA is an important center for Darwin research in North America and also provides online access to a large quantity of Darwin letters.

vii. Other materials of and by Charles Darwin, such as indexes, specimen lists, sketches, maps, etc., and resources relevant to this study's research questions: some transcribed and published specimen lists, sketches, etc. are available through ULS and ILL, such as Keynes's (2000) *Charles Darwin's Zoology Notes & Specimen Lists from H.M.S. Beagle*; other unpublished materials are stored at Cambridge.

viii. Various materials about Charles Darwin that are based on eyewitness and/or first-hand interactions with Darwin, such as son Francis Darwin's (1898) edited book *The Life and Letters of Charles Darwin: Including an Autobiographical Chapter* as well as Weitzel's (1995) *The Journal of Syms Covington* by Darwin's *Beagle* exploration assistant: books are available through ULS or ILL; the transcribed Journal of Syms Covington is available for reading and searching electronically via Australia's Bright Sparcs website at the University of Melbourne.

b. Secondary sources This study focused principally on the primary sources cited above. Secondary sources were utilized to (1) facilitate the finding of relevant data, (2) develop and explain key points, (3) provide necessary and beneficial contextual information and references, and (4) augment data from primary sources where appropriate. This dissertation's literature review summarizes many secondary source materials. The following is a list of secondary sources that were considered and/or used during this study:

i. Academic and non-academic articles, monographs, books and book series, conference papers, encyclopedias, treatises, handbooks, pamphlets, atlases, etc. pertaining to Charles Darwin: available through ULS or ILL.

ii. Previously published and unpublished dissertation-related or other academic research pertaining to Charles Darwin: available through ULS, ILL, or via online access.

iii. Non-primary source electronic media and audiovisual materials pertaining to Charles Darwin: available through ULS or ILL.

c. Sources consulted during the course of research

i. Materials and/or information attained via on-site visits to or research at Charles Darwin-related locations, such as Darwin's Down House in Downe, Kent, England, the

Darwin collections at Cambridge University, England, and New York City's American Museum of Natural History's Darwin Exhibition from November 2005-May 2006. The Darwin Exhibition in New York City was visited on December 24, 2005. Darwin materials located in Cambridge University Library's Manuscripts and Rare Books Rooms were examined on March 6 & 8, 2006.

Figure 3. Cambridge University Library, built 1931-1934, preserves and provides access to many of Darwin's letters and archival materials.

Darwin's Down House country home, now an English Heritage museum and historical site, was visited on March 7, 2006 for study and research photo-taking, approved by the Curator, Ms. Tori Reeve.

Figure 4. Down House in Downe, Kent, England was Charles Darwin's home from 1842 until his death in 1882 and is maintained by English Heritage.

The loss of one full day, due to adverse weather condition delays in traveling from the U.S. to the UK, did not permit additional Darwin-related research to be conducted at the British Museum, the British Library, and the Natural History Museum's Darwin Centre in London. It was possible to briefly visit Darwin's grave at Westminster Abbey and see the modern location of the Royal Society. The American Philosophical Society

(APS) Library in Philadelphia, PA houses a large collection of primary and secondary Darwin source materials, including approximately 950 original letters by and to Darwin. The APS Library was visited on April 14 & 17, 2006.

Figure 5. The American Philosophical Society (APS), of which Charles Darwin was a member, is located adjacent to Independence Hall in Philadelphia, Pennsylvania. The APS houses North America's largest collection of original and copied Darwin materials, including Darwin's "I am greedy for facts" letter, which was written to Sir James Paget, Queen Victoria's surgeon, in 1867.

d. Data collection during the dissertation Random exploratory data collection was conducted during the preparation of the proposal. This was a necessary step in preliminarily formulating, and, afterwards, evaluating and presenting the arguments in support of the rationale, significance, and need for conducting this study.

i. Darwin Correspondence Online Database (DCOD): After the dissertation proposal was approved by the dissertation committee in the spring of 2006, more formalized data collection commenced. Specific time periods in Darwin's life were examined, such as the 1831-1836 *Beagle* voyage and the years preceding *Origin*'s publication in late 1859. It was hypothesized that these periods - the former a period when much information was collected by the budding naturalist and the latter a period in which abundant information was sought, organized, managed, communicated, and used to produce *Origin* - would likely yield useful data for this study. Initially, the Cambridge University-published volumes of *The Correspondence of Charles Darwin* (CCD) and Cambridge University's Darwin Correspondence Online Database (DCOD) were used interchangeably. But the DCOD quickly became the preferred research tool for several reasons. Firstly, the electronic nature of the DCOD makes its updating much easier and faster. Because Darwin-related letters continue to be located and added to the collection of extant correspondence each year, the DCOD can more seamlessly assimilate these edited and transcribed letters into its electronic format within the correct time period to which they belong; already published volumes of the CCD cannot be as easily updated and have to include newly discovered post-publication letters in later editions. For example, CCD Volume 7 1858-1859 includes a supplement at the back, containing "all the letters that have been located or re-dated since the publication of *Correspondence* vols. 1-6, covering the years 1821-57" (p. 465). Additionally, the more malleable nature of the web-based DCOD enables speedier correction of errors and implementation of other changes (though, of course, the DCOD still requires human beings to follow through on making such corrections and updates as needed). Thus, an important advantage for the researcher using the DCOD is having greater expectations and more confidence about being able to remotely access - within one standard web location, rather than multiple print volumes - the most up-to-date transcribed and edited Darwin correspondence possible.

Secondly, the DCOD's web links throughout the database make a wide range of searches possible, convenient, and reliable. With just a couple of clicks, sifting through the Darwin letters—moving from a letter summary to the foot-noted full-text of a letter, and, if desired, having the option of navigating back and forth to a variety of classified indexes and search options—is streamlined and more productive. Searching and reading letters grouped by an index point is also a very beneficial feature of the DCOD; for instance, looking at letters indexed by the index point "information, data, scientific description" was convenient and productive in locating relevant, insightful data. The DCOD also makes it possible to collate all DCOD transcribed letters by an individual, like Thomas Henry Huxley or Alexander von Humboldt. This is a significant benefit in terms of chronological organization and the resulting ease in longitudinally investigating and tracking potential trends and/or changes.

Thirdly, transcribed letters are annotated and many are available in full-text (eventually all will be full-text accessible, once the editing and transcribing of the remaining years is completed by Cambridge), which facilitates browsing and the making of search relevance judgments. At the time of this study's data collection in 2006, Cambridge

University had made more than 2,000 letters by and to Darwin from 1837 to 1859 available on the DCOD in full-text.

Fourthly, information architecture aspects like the font style and size, incorporation of color variations, overall organization of the pages, and provision of user-friendly, time-saving hot links enhance a multi-faceted tool that is visually intriguing and intellectually stimulating. The DCOD's homepage displays periodic news and updates regarding the database project's ongoing status, access to newly available letters on the site, recent publications, and the continuing search for and discovery of additional Darwin letters. These aspects, combined with the DCOD's readily updatable nature, invoke a sense that the database is alive, dynamic, and evolving. Most importantly, the aggregate of these features makes the DCOD extraordinarily useful for concentrated Darwin research. Its utility and user satisfaction will be amplified when keyword searching and full-text availability of all extant Darwin letters have been implemented.

Fifthly, on January 21, 2007, it was discovered that "free text" or keyword searching on the DCOD was now available; the site had displayed a message, first seen at least a year ago, stating that this feature would become available sometime in the future. Having this free text capability available, albeit toward the end of the dissertation research period, greatly facilitated searching and retrieval. For example, any letter containing a root of the word 'greedy' was now retrievable, which had not been possible before the free text upgrade. Another upshot was that free text searches produced hits for any derivative of a search term or phrase, regardless of whether the search terms were in the text, editorial footnotes, or calendar summaries of the DCOD. Searching for letters using LIS-oriented terms, such as compiling, portfolios, cataloguing, or shelves, was also made possible. Looking for any or all instances with an unusual phrase, like 'screwing knowledge out'—a phrase expressed by Darwin that was uncovered in one of his letters—was similarly now possible. Also, recollecting a statement in which Darwin had written "I work all my friends" and wanting to quickly navigate to the specific letter containing that phrase was also made more convenient and expedient by being able to enter that phrase within quotes in the free text search box, and then being directed right to that letter. Hence, moving throughout the database overall was substantially simplified.

ii. The Correspondence of Charles Darwin (CCD): Although the majority of this dissertation's data collection and analysis relied on the DCOD, the CCD was beneficial in several ways. Occasionally, summarized but not yet full-text available letters were located in the DCOD. Fortunately though, such letters were often published as full-text in the CCD. Differences between the DCOD and CCD will likely diminish or disappear in the future; the differences are due to the varying stages of completion for the DCOD and CCD transcription, editing, and publishing projects. Eventually, all letters for which there is full-text will be available in full-text. Copyright-related issues may be a factor impacting current full-text availability too, as Cambridge and other holders of original Darwin letters, such as the American Philosophical Library, do not own all of the Darwin letters.

Secondly, the CCD volumes' provision of full-text letters is both useful and essential in another way. Currently, the DCOD only offers full-text letters for the years 1837-1859. The CCD has recently published volume 15, covering the year 1867. Cambridge's efforts continue toward achieving the goal of publishing the projected 30-volume Darwin correspondence set through 1882, the year of Darwin's death. Therefore, at present the CCD is the definitive source for full-text letters not available on the DCOD, i.e. 1821-1836 and 1860-1867.

Thirdly, the CCD provides some supplementary materials in the back of each volume, which are helpful to examine. For example, CCD Volume 1 1831-1836 includes "Appendix IV: The books on board the *Beagle*". This appendix offers insights about the print resources to which Darwin may have had access, since the *Beagle*'s catalogues have not survived. From extant *Beagle*-related writings it has been possible to compile a list of the print materials that were aboard the *Beagle*, which this appendix discusses. Inclusion of a diagram illustrating Darwin's shared poop cabin where the books on the *Beagle* were shelved is informative. This diagram is also indicative of the mix of textual and graphic documentation, including scientific sketches and black and white photographs of Darwin, his family, and colleagues, provided in the CCD volumes.

Building on the previous point regarding supplementary materials, the CCD offers the advantage of providing the actual transcribed annotations that Darwin and other correspondents made on various letters. Currently, the DCOD uses red font, e.g. a1, to note places within the letters where annotations are present but refers the reader to the CCD's published volumes to view those annotations. Similarly, the DCOD specifies that red text indicates a diagram or table in an original letter. In the absence of a web link to an image, the DCOD directs the reader to the CCD's published volumes.

iii. The Complete Work of Charles Darwin Online (CWCDO): On October 19, 2006 The Complete Work of Charles Darwin Online (CWCDO), a website hosted by the University of Cambridge, was launched. Retrieved December 5, 2006, from http://darwin-online.org.uk/. Previously, a beta version of the site, entitled The Writings of Charles Darwin on the Web, provided access to some Darwin-related writings. Initially it was noticed, as well, that the upgraded database was entitled The Complete Work of Charles Darwin (CWCD) and at some unspecified point the word 'Online' was added to the end of its name. The new website purportedly provides free electronic access to more Darwin materials than ever before available, presenting "more than 50,000 pages of searchable text and 40,000 images of both publications and transcribed manuscripts." Retrieved December 5, 2006, from http://darwin-online.org.uk/release.html. This dissertation relied primarily for data collection upon the DCOD and CCD, discussed earlier. But The Complete Work of Charles Darwin Online website was also helpful in providing some information for this study, cited where applicable. A significant strength of the CWCDO site is its ability to allow searching by keyword, which the DCOD also made available around January 1, 2007.

e. Data collection and analysis methods used The research stages of data collection and data analysis were often performed concurrently during this study; a certain minimum level of analysis was required in order to determine whether the data was relevant and should be collected. Given the thousands of Darwin-related letters through which to sift, decisions about what data to collect were of paramount importance. Likewise, deciding what not to collect was equally vital, in terms of time and effort in organizing and subsequently using the data.

The research stages of data collection and data analysis were conducted using several different means at the outset of the post-proposal dissertation. These stages evolved as the study continued. Early into the study it was found that DCOD searching made it expedient and authoritatively reliable to (1) find, (2) read, to ascertain the relevance of letters vis-à-vis Darwin's information behaviors but also assimilate information in furtherance of a broader understanding of Darwin generally, and, (3) print out, if a letter were deemed useful and pertinent, summaries and/or the full-text of letters that contained relevant instances of Darwin's behaviors. Next, these print-outs of letters were reread, analyzed, and marked with pen and/or hi-liters, incorporating annotations throughout the print-outs. For example, abbreviated codes such as iSeek, iOrg, iComm, and iUse were used respectively to denote information seeking, organizing, communicating, and/or use. Notes were made, often at the top portions of the print-outs' first pages or in proximity to identified instances throughout the print-outs, summarizing relevant observations or questions about each letter. Some notes were brief, such as "good exs. of iOrg", "refs.: CD's strategy for using info./facts", and "Query: what does CD mean by 'sketch'? (see after f7)". Other notes were more lengthy and multi-faceted, like:

> Excellent refs.: use in dissertation: evaluating sources; CD's method for evaluating info.; CD's advice re collecting facts on breeding, improving breeds; importance of interacting w/people to glean info., e.g. CD's attendance at a local gathering of pigeon fanciers & breeders; CD acknowledges difficulty in reading his own handwriting.

The following is an example of annotations made on a letter during this study, which provides some insights into the study's efforts to identify categories describing Darwin's descriptive information behaviors: "Excellent source: use in dissertation; grounded theory ref: the way facts fall into groups; info. collecting: like Croesus overwhelmed with my riches in facts; info. seeking, maximizing, extracting, networking: I work all my friends; info querying; info experimenting". Some annotations made on the print-outs did not pertain directly to Darwin's information behaviors but were noteworthy for offering insights about Darwin in general, the man and the person. An example of this is a note made on a post-*Origin* letter to T.H. Huxley dated December 9, 1859: "interesting ref. by CD re his self-image" connected by an arrow to Darwin's statement, "It will be God's blessing if I do not become the most conceited man in all England." After the letters were printed out and annotated, they were organized chronologically by earliest to latest date in two 780-page capacity 3-ring binders.

Data collection and analysis by means of print sources, such as the CCD, differed in some ways from use of the DCOD. Because of the expense and multi-volume nature of the CCD volumes, borrowing the CCD books from the library made sense fiscally, rather than purchasing them. Since marking up and annotating the pages of these borrowed books was not an option for obvious reasons, data collection from the CCD was more laborious and required different actions than data collection and analysis when using the DCOD. The strategy used for collecting data from the borrowed CCD books required (1) a reading of the letters, (2) placement of colored 6″ x 2″ rectangular Post-it™ page markers to designate potential instances for subsequent data collection, and (3) eventual recording of the designated instances into a 3-ring notebook or directly into the dissertation's work documents via Microsoft Word™. (Photocopying designated pages from CCD books could have certainly been an option but would not have worked well with the Post-it page markers on the margins and would have necessitated incurring additional expenses for many pages of copying.) As discussed earlier when comparing the pros and cons of the web-based DCOD and the print CCD, because of the more complex and less malleable nature of data collection and analysis involved in using the CCD, this study gravitated to primarily performing data collection and analysis by using the DCOD.

Several months after post-proposal data collection had begun, Atlas.ti™ qualitative data software was purchased to help with and possibly migrate to managing the Darwin correspondence data. Following the proposal defense, this researcher thought that perhaps a data management software system might be a better method to use in this study than reliance upon a predominantly paper document-based method for data collection and analysis. Various data management options, such as NUD*IST and Atlas.ti, were investigated by reading several journal articles and looking at some web-based data management authorities. NUD*IST had briefly been used before in an ethnographic research course but Atlas.ti was trial-tested during this consideration. Ultimately, Atlas.ti was selected and purchased through a student research license.

However, after receiving and trying out various features of Atlas.ti for several days this researcher decided to forego utilizing Atlas.ti for this study. Using Atlas.ti proved both unwieldy and unintuitive in comparison to actually being able to physically touch, mark up, organize and reorganize if desired, the printed-out, annotated DCOD correspondence. After several uses of various Atlas.ti features, it became apparent that the amount of time it would take to become proficient with the operation and quirks of Atlas.ti outweighed its potential benefits, when weighed against the more traditional print-focused historical analysis already underway, which was yielding relevant, readily usable data. Since a good working method for collecting, organizing, and using the Darwin correspondence data had already been developed and field-tested, as outlined above, for the purposes of this dissertation the flirtation with jumping to a data management software tool like Atlas.ti was not pursued further. But the brief dalliance with Atlas.ti was valuable in highlighting the differences between the two data management methods, vis-à-vis the time, research tasks, and proficiency considerations involved. And, coming full circle, thinking about and field-testing the data collection and analysis methods in new ways, in turn reinforced the decision regarding the methods selected and utilized upon reconsideration. As a final comment on this point, it is interesting to note that electronic technology was the preferred tool for accessing, collecting, and analyzing the data in this study, though a more traditional paper document strategy was the preferred means for organizing, further analyzing, and using the data after its collection. Hence, as sources and organizing schema, both electronic and print media were beneficial to this study.

V. DATA ANALYSIS

A. INTRODUCTION

As mentioned previously, several levels of analysis were conducted when reading the Darwin letters examined in this study. Analysis was conducted at a threshold level in order to determine the relevancy of each letter's content in relation to the research questions. Letters deemed to have relevant data were annotated or marked for data collection later. The data collection and data analysis stages, thus, were frequently not distinct steps; they were often performed simultaneously. The nature of the data necessitated this approach because the potential data set, i.e. 14,500+ extant Darwin letters, was so massive: examining each and every letter would have been beyond the scope of this dissertation. Additionally, as discussed previously and below, the well-documented difficulties inherent in deciphering Darwin's handwriting make reading and analyzing the remaining unedited, untranscribed, and unpublished Darwin letters problematic for interpretation at present.

After the initial data analysis stage, historical analysis of the Darwin letters was continually conducted throughout various stages of the dissertation. Letters from various Darwin time periods were examined using a variety of strategies. Some letters were read based upon a chronological strategy, such as reading a sequence of letters dated between January 1859 and March 1859. Some letters were read based on their index points.

Other letters were read because they were written by a specific individual. Throughout the proposal preparation phase, this strategy was developed for narrowing the daunting potential data set of 14,500+ extant Darwin letters: as reading of the letters progressed, key correspondents, whose writings from and to Darwin were yielding data considered significant and relevant to the study's objective of identifying and better understanding Darwin's information behaviors, would be noted. Examples of such information behavior-relevant Darwin correspondents include Darwin's mentor and *Beagle* voyage recommender, John Stevens Henslow, and scientific peers, Charles Lyell, Joseph Dalton Hooker, Thomas Henry Huxley, and Asa Gray. Then, select letters from this subset of core correspondents could be focused upon and tracked. This strategy offered the advantage of maximizing the likely finding of relevant, useful data, after preliminary, exploratory searching, especially after the researcher had become more knowledgeable about and familiar with the several thousand-strong "cast of characters" comprising Darwin's vast global correspondence network.

During the data collection and analysis stages, grounded study was also conducted periodically. Namely, as data was collected, analyzed, and organized, it was intermittently reanalyzed to see if new insights were emerging. Observations about the data were recorded by the researcher in a 3-ring binder of dated loose-leaf research notes and were periodically reviewed. It was hypothesized at the study's outset that, in the vein of Ellis et al.'s (1993) identification of eight information behavior categories for physical and social scientists discussed in the literature review above, Darwin's information behaviors could be classified into various categories. It was reasoned that the nomenclature and definitions of these categories might be revealed and derived from analysis of Darwin's writings. Once the study commenced and as more and more Darwin letters, writings, and scholarly secondary sources were analyzed, the data and grounded theory analysis did in fact support the idea that Darwin's descriptions of his own information-related activities exhibited throughout his life could be used to create information behavior categories classifying and describing his respective information behaviors.

B. INTRODUCTION OF BROAD CONTEXT INFORMATION BEHAVIORS (BCIBS)

Spink and Currier (2006b) examined the information behaviors of several historical persons through the human information behaviors of information seeking, organizing, and use. During this dissertation, it was decided to expand the examination of Darwin's information behaviors beyond information seeking, organizing, and use. Thus, this dissertation utilizes five overarching information behavior categories to fundamentally encompass, analyze, conceptualize, describe, and diagrammatically depict Darwin's information behaviors. It was also decided that these five overarching categories would be characterized as broad context information behaviors (BCIBs). Broad context information behaviors (BCIBs) are general information behavior categories, which provide a conceptual framework and systematizing context within which related information behaviors can be grouped, situated understood, and depicted within graphic models.

Three of these five BCIBs are information seeking, organizing, and use. Two additional BCIB categories, information communicating and information managing, were utilized as well. These BCIB categories were utilized in this dissertation to identify, group, describe, and facilitate the depiction of relationships among other information behaviors, within an overarching framework.

C. IDENTIFICATION OF DESCRIPTIVE INFORMATION BEHAVIORS (DIBS)

Within the overarching BCIB framework of information seeking, organizing, managing, communicating, and use, more than fifty descriptive information behaviors (DIBs) that were exhibited by Darwin were identified. Descriptive information behaviors (DIBs) are narrower human information behavior (HIB) classification categories than broad context information behaviors (BCIBs). DIBs serve as conceptual and graphic tools for specifying, via words and examples, the relevant characteristics of a person's information behaviors. DIBs radiate from at least one or more of the BCIB categories.

Somewhat surprisingly, many of the DIB categories needed no modifying in terms of their nomenclature; they were able to be derived and named using Darwin's own written words. Some examples of these are the DIBs of collecting, observing, pumping, arranging, compiling, reading, and experimenting. Each of this type of DIB is named based on Darwin's own recorded statements about his activities.

Using Darwin's information behavior-describing words in order to formulate nomenclature for the descriptive information behavior categories was beneficial as a means of avoiding, or at least mitigating, potential misapplication of misleading or inaccurate terms, used for naming and describing Darwin's actions and thoughts. It was also helpful in diminishing potential misinterpretation of Darwin's words and intent and reducing the improper transfer of contemporary thinking and terminology into Darwin's 19th century time period.

It was not clear before the data collection and periodic grounded study analysis were underway to what extent Darwin's writings would directly address his information-related thoughts and actions. Once the post-dissertation proposal defense period of data collection and analysis began and progressed, it became increasingly evident that Darwin wrote a great deal about people, things, and activities related to information. Many instances involved Darwin's own interactions with information. This was also true in terms of episodic frequency; each year of Darwin's life examined in this study revealed abundant instances of his information-related activities and thinking. In addition, ample prima facie evidence of numerous and diverse kinds of information behaviors exhibited by Darwin were readily and frequently found.

One of the desired, and in large part achieved, results of identifying and naming DIB categories that originated from Darwin's own words was to derive categories, where possible, whose names and meanings would be readily comprehensible and applicable to a 21st century information age context. So, for instance, information-related activities such as 'collecting' and 'observing' are still fundamentally defined and understood in a similar way by people, whether living in Darwin's 19th century Victorian era or the electronic technology-centered 21st century. Thus, when Darwin says he collected rocks in Patagonia or observed finches in the Galapagos, one is able to understand and rely upon what he means with a high degree of certainty and comfort. Though certainly the methods of collecting and observing have changed and evolved (e.g. Darwin era glass specimen bottles and metal-clasped foolscap paper-holding notebooks supplanted by modern age durable, plastic Petri dishes and wireless Blackberrys™), the essential meanings remain the same.

Other DIB categories analyzed and discussed below also stem from Darwin's information-related activities. However, some of these DIBs were constructed or selected for comprehensibility reasons and to avoid confusion or ambiguity; this is contrasted with the previous DIB examples discussed above, which originated directly from Darwin's own words and did not require changes in nomenclature. Some DIB categories were modified or constructed to promote clarity and comprehension. An example of this is the DIB, corresponding: this information behavior stems from Darwin's communicating of information by exchanging written letters. As noted before, Darwin wrote and received thousands of letters. However, in the letters he wrote, Darwin uses the term 'writing', not 'corresponding', in referring to the act of sending or receiving letters and other items through the mail. When he does mention the word corresponding, it relates to its other meaning, i.e. similar in character, form, or function. Hence, it was decided that the term corresponding would be used.

An example of a constructed category term is 'delegating', which Darwin does not describe or name in his writings. For some more menial, less creative information-related tasks, Darwin farmed out or, using modern parlance, outsourced some of these jobs. Examples of these kinds of outsourced tasks are the information organizing list-making and indexing jobs done by several Downe village schoolteacher copyists, whom Darwin hired. Information seeking jobs performed by his former *Beagle* servant-cum-Australian émigré Syms Covington are other examples of the delegated kinds of work Darwin farmed out to other people to perform on his behalf. Delegating, thus, is an effective descriptive information behavior category for describing and encompassing this type of information behavior engaged in by Darwin: an information-related task, sometimes but not always involving monetary compensation, which Darwin assigned or commissioned another person to perform, for Darwin's direct benefit. Although Darwin describes the tasks he delegates to various people, such as his copyists, Syms Covington, and family members who frequently assisted with copying and editing, he does not specifically use an information behavior category-like term that is suitable for describing those actions. So, for the objectives of this study, delegating is employed as a constructed DIB category to classify and describe Darwin's behaviors of this kind.

VI. DISCUSSION

A. EXPANSION OF BROAD INFORMATION BEHAVIOR CATEGORIES' FRAMEWORK

The objective of research question #1 in this dissertation was to identify Charles Darwin's information behaviors. That question asked, "What were Charles Darwin's information behaviors? More specifically, what information did Darwin need and how did Darwin seek, organize, and use information?" During the proposal stage of this dissertation, information seeking, organizing, and use were the three HIB broad information behavior categories envisioned as appropriate and sufficient for examining and framing his information behaviors.

B. INFORMATION BEHAVIOR CATEGORIES

After the proposal defense, however, as the study commenced, analysis of some of the early data led to the conclusion that the three broad information behavior categories - seeking, organizing, and use - were not providing as comprehensive and intuitive a framework for conceptualizing and overarching all of Darwin's information behaviors. For example, some of his behaviors such as corresponding and delegating, explained earlier as well as in more detail below, did not fit as logically within the categories of information seeking, organizing, and use; shoehorning them into one of the three categories would not yield an optimum categorization.

Fortunately, a better framework emerged. Grounded study of the information behavior-relevant data that was emerging from collection and analysis of the Darwin correspondence revealed two important insights: in many instances Darwin was acting (1) as an information manager and (2) as an information communicator. Indeed, management and communication of information by Darwin both constituted and explained significant aspects of his relationship with information. Thus, it was determined that two broad information behavior categories, information managing and information communicating, needed to be added to the research questions and design in order to more accurately and effectively address and frame the full range of his information behaviors.

C. RATIONALE FOR ADDING INFORMATION MANAGING AND COMMUNICATING CONTEXTS

Because this dissertation is an LIS-oriented study, modifying the research questions and design by adding the two additional categories of information managing and information communicating was disciplinarily warranted on several bases. Firstly, communication studies are recognized as an important component of LIS research and also are constituent departmental components of a number of LIS schools. Secondly, knowledge management, as it is known now, is at its core a 21st century conceptualization of information management, which has developed into an accepted area for study within LIS. Knowledge management also has become an accepted facet of corporate industry practice. For these reasons then, adding the broad categories of information managing and information communicating, in order to better frame and examine Darwin's information behaviors, was both logical and well-founded.

D. BROAD CONTEXT INFORMATION BEHAVIORS (BCIBS) FRAMEWORK DEVELOPMENT

In addition to thinking about what additional broad categories of information behaviors might be useful for more effectively and comprehensively investigating and identifying Darwin's information behaviors, a means for better conceptually organizing and representing those information behaviors was considered. Specifically, the question was whether a framework could be developed that would facilitate a broad categorizing of Darwin's information behaviors and also enable more narrowly tailored description of his information behaviors; in short, both a macroscopic and microscopic view. Conceptually classifying his information behaviors in a textual and graphic manner was also an objective.

As discussed earlier in this dissertation, the emerging HIB field has chiefly studied the information needs and seeking behaviors of people. Some studies involving the information organizing, managing, communicating, and use have also been conducted. Hence, all of these categories of human information behaviors have a foundation as areas for inquiry by researchers. Because these categories have been employed empirically by researchers to overarch and group studies, e.g. the category of information seeking used to overarch many types of studies about information seeking, these categories offer some inherent advantages as broad classificatory headings for grouping and depicting relationships with other information behaviors.

Through grounded study in this dissertation, the term "broad context information behaviors" (BCIBs) was developed and used to name these general categories, e.g. information seeking, organizing, managing, communicating, and use, which have historically been utilized to study, classify, and represent various general types of information behaviors. The "broad context" part of the term refers to (1) the general circumstances that form the setting for an information behavior, and (2) the general classification means by which it can be fully understood, assessed, and situated. The BCIBs are general information behavior categories that provide a conceptual framework and organizing context within which related information behaviors can be grouped, situated, and understood.

E. DESCRIPTIVE INFORMATION BEHAVIORS (DIBS) DEVELOPMENT

As the dissertation progressed, analysis of the information behavior-related data generated another conceptual construct, which was termed "descriptive information behaviors" (DIBs).

This term refers to narrower HIB classification categories than the BCIBs discussed above, such as information seeking and managing. DIBs radiate from one or more of the overarching BCIBs. DIBs serve as conceptual and graphic tools for specifying, via words and examples, the relevant characteristics of a person's information behaviors. Though the BCIB categories are useful for providing general category conceptualizations of Darwin's information behaviors and serving a classifying function by enabling the grouping of more specific information behaviors under those broad categories, the DIB categories offer a number of advantages for more focused, precise analysis, description, and substantiation of Darwin's information behaviors. For one, the DIBs can be used to flesh out and illustrate the subtle, complex dimensions of various broad categories. As example, the BCIB category of information seeking serves as an umbrella category for a range of related information behaviors possessing an information seeking aspect: examples of these information seeking-related DIBs are Hunting/Searching, Detecting/Finding, Collecting, Observing, Skimming/Browsing, Reading, Referencing, and Asking/Questioning, which are defined and discussed in extensive detail below.

Fifty-two DIBs indicating Darwin's information behaviors were identified at various points throughout this study. These DIBS are listed and defined below.

F. BCIBS, DIBS, AND RESEARCH OBJECTIVES

The BCIB framework and the DIBs are relevant to and useful for addressing research question #2: "within what contexts did Darwin manifest his information behaviors? How did such contexts influence Darwin's information behaviors?" The BCIB framework and DIBs approach developed in this dissertation facilitate both macroscopic and microscopic analysis of the diverse contexts within which Darwin's information behaviors occurred. They also facilitate description of these diverse contexts and their depiction by means of graphic models and photographic images. In addition, they promote and satisfy two important objectives of this dissertation: (1) better understanding and explaining Darwin's information behaviors, and (2) graphically representing Darwin's information behaviors in a model. e.g. Descriptive information behaviors (DIBs)

The BCIB framework and DIBs approach were also pertinent as applied to research question #4: "What model(s) can be developed to explain and illustrate Darwin's information behaviors and potential changes/evolution of his information behaviors?" Another way of thinking about the five broad information behaviors framework is to look at Darwin's relationship with information as broadly characterized by five distinct but interrelated roles: as information seeker, information organizer, information manager, information communicator, and information user. The DIB categories can be viewed as examples of Darwin's larger information roles. So, for example, within his role as an information organizer one can see specific types of Darwin's information organizing through narrower information behavior tasks, such as abstracting, annotating, arranging, cataloging, classifying, and compiling. A model depicting this BCIB and DIBs approach is provided below.

Research question #3, "Did Darwin's information needs and behaviors change/evolve over his lifetime, and if so, how?", was also considered during this study. This question will also be addressed in the Areas for further research section below.

G. INTRODUCTION TO DESCRIPTIVE INFORMATION BEHAVIORS (DIBS)

Fifty-two descriptive information behaviors (DIBs) illuminating Darwin's information-related activities were identified through this dissertation research. These DIBs were derived and developed from analysis of Darwin's writings, specifically relating to instances where he referred to his information-related thoughts and activities. The identification and construction of these DIB categories were also informed and supplemented by analysis of letters written by some of Darwin's correspondents to him, as well as scholarly secondary sources and editorial notations, as noted. Some of the descriptive information behavior categories were also informed by Ellis et al.'s information seeking categories, previously discussed in the Literature Review. A list of the DIBs and their respective definitions is provided in the next section. The development of these DIB definitions was informed by the general definitions of these terms contained in *The New Oxford American Dictionary* (2001). Following the list and definitions of the fifty-two DIBs below, several features of the DIB categories are explained. Each DIB is then specifically discussed and examples illustrating each DIB category's applicability to Darwin's information behaviors are presented and cited.

H. LIST AND DEFINITIONS OF DIB CATEGORIES DETAILING CHARLES DARWIN'S INFORMATION BEHAVIORS

1. Hunting/Searching: looking for information and objects.

2. Detecting/Finding: discovering or identifying the presence or existence of information and items.

3. Collecting: systematically acquiring and gathering together information and items.

4. Observing: watching; often taking mental and written note of things and information.

5. Recording/Note-taking: setting information down in writing or some other permanent form for later reference.

6. Annotating: adding notes to information and items in order to give explanation or comment.

7. Abstracting: making a written summary from the contents of printed matter or information.

8. Borrowing: taking and using printed information or objects that belong to another, with the intention of returning them.

9. Lending: granting another the use of printed information or objects with the understanding that they will be returned.

10. Questioning/Asking: saying something, posing a question, or making a request in order to obtain an answer or information.

11. Pumping: persistent questioning with the aim of eliciting and attaining all possible information or items from someone.

12. Giving/Supplying: making needed or wanted information or things available to another, typically by gratis and permanent transfer of possession.

13. Procuring: obtaining, often via purchase, information and items first-hand or through another party.

14. Corresponding: communicating information by exchanging written letters, typically delivered through the postal service.

15. Face-to-face networking: interacting in person with people at a venue, where the exchange of information and development of contacts can occur.

16. Delegating: assigning and entrusting an information-related task or responsibility to another person, typically someone who is less senior or in the delegator's employ.

17. Packaging: placing objects or information inside some type of physical material, for purposes of delivery, storage, preservation, borrowing, lending, or sale.

18. Transmitting/Delivering: sending information and items by water or land transportation, typically through third parties.

19. Skimming/Browsing: visual scanning of written materials quickly or cursorily to gain an impression of the contents.

20. Reading: viewing and comprehending the meaning of information via written or printed sources; typically of more duration than skimming and browsing.

21. Referencing: using a source of information to ascertain additional information.

22. Literature reviewing: skimming, reading, and referencing of print sources, narrowly focused on a specific topic or field, for the purpose of surveying the breadth and depth of known information on that topic or field.

23. Marking/Scoring: writing or affixing alphabetic characters, symbols, lines, notches, colors, etc. onto information or items, as part of an organization schema or to denote that some kind of action has occurred or needs to be performed.

24. Labeling: writing on or attaching material with words, names, symbols, or colors to information and items; typically for identification, organization, or convenience.

25. Numbering: assigning a number to information and objects; typically to indicate a position in a series and related to the arranging, listing, classifying, etc. of items and information.

26. Listing: writing connected items, names, tasks, or information, which are frequently organized by category or numbered in order of priority or quantity.

27. Indexing: making an alphabetical listing of information, names, subjects, etc., with references to the places where they occur, typically found at the end of a book.

28. Cataloging: making a systematic arrangement of items or information.

29. Classifying: assigning items and information to a particular class or category.

30. Evaluating/Relevance-determining: assessing the value, usefulness, or applicability of information and things.

31. Recommending: to advise or approvingly suggest information, items, a procedure, or a venue as being suitable for a particular purpose.

32. Preserving: maintaining information or items in their original or existing state.

33. Copying: making a similar or identical version of information.

34. Extracting/Excising: removing, taking out, or deriving information or things, often a portion from a larger thing.

35. Incorporating/Inserting: uniting or merging information or objects with another existing entity.

36. Arranging: putting items and information in a neat, required, and/or useful order.

37. Filing/Storing: placing information and items in a cabinet, box, folder, portfolio, etc., in a particular order, for purposes of preservation and easy reference.

38. Retrieving: regaining possession of information and items, following prior acquisition and storage.

39. Reflecting: thinking about information, often deeply, carefully, and at length.

40. Experimenting: performing a scientific procedure to determine something or to assess the meaning of information through the scientific method; also, trying out new concepts or ways of doing things.

41. Compiling: assembling information collected from other sources.

42. Verifying/Confirming: making certain that information is true, accurate, or justified.

43. Modifying/Adapting: making partial or minor changes to information or an object, typically in order to improve it or make it more useful.

44. Revising/Altering: Reexamining, reconsidering, and making alterations to information or something, often due to additional information, new insights, or the need to correct errors.

45. Understanding: mentally interpreting and comprehending information, in a manner typically involving the use or application of that information.

46. Explaining: making information understandable by describing it or revealing relevant facts or ideas.

47. Quoting: mentioning or referring to information in order to provide evidence or authority for a statement, argument, or opinion.

48. Publishing: to print information in a written format for sale or free distribution.

49. Presenting: to deliver information orally, typically to a group or audience.

50. Claim-staking: using information in order to assert one's ownership or priority in something.

51. Dispersing: spreading and promoting information widely in the form of tangible items and intangible ideas.

52. Propagating: facilitating the dispersal of information by others.

I. FEATURES OF DIB CATEGORIES

The descriptive information behaviors (DIBs) listed and defined above are numbered in the order presented, principally for organizational and reference purposes. The numbers associated with each respective DIB category, e.g. 1 for hunting/searching, do not connote a required sequence of performance or a strict linear progresssion. The DIB categories identified in this dissertation are intended to reflect iterative and cyclical behaviors, which were manifested by Darwin in differing order, time, and frequency. They represent varied aspects of Darwin's composite information process that were performed by him at different times throughout his life. However, though the numbered DIB list is not a successive information process list, i.e. 1. hunting/searching need not be performed before 2. detecting/finding, and so on, it does represent a flexibly structured information process that corresponds with the broader information categories of seeking, organizing, managing, communicating, and use. For example, the descriptive information behavior categories of detecting, collecting, and observing are primarily associated with information seeking. Hence, those behaviors have low numbers. Similarly, information use occurs toward or at the end of the information process, and thus, the descriptive information behaviors of claim-staking, dispersing/disseminating, and propagating have higher numbers.

J. DESCRIPTIONS AND EXAMPLES OF DIBS FROM DARWIN CORRESPONDENCE/ WRITINGS

In this next section, the fifty-two descriptive information behaviors (DIBs), which were identified and developed in the course of this dissertation research, are described. Specific examples from a variety of Darwin source materials are provided, with most instances emanating from the extant Darwin correspondence. In addition, digital images, attained during the British research trip in March 2006, are incorporated in this section to illustrate a number of the DIBs. CD is used as an abbreviation for Charles Darwin; other abbreviations are listed above in the Abbreviations section. Dates are listed according to their provision by the DCOD. Bracketed portions of dates, e.g. 5 Dec [1849], signify whole or parts of dates that are missing or not listed on some letters, with the bracketed dates representing the best estimates of dates as conjectured by Cambridge University researchers, by means of comparison with other evidentiary sources.

K. EXAMPLES OF DESCRIPTIVE INFORMATION BEHAVIORS VIA THE DARWIN CORRESPONDENCE

1. Hunting/Searching: looking for information and objects.

Hunting or searching for information was a common activity engaged in by Darwin throughout his life. It also seems apropos to use the term hunting, as two connotations of the term were important to Darwin. As a young adult, hunting and shooting animals were popular activities for him. Additionally, a number of instances from Darwin's letters show that he also used the word in terms of its searching connotation. Browne (1995) makes the point that, "Hunting and shooting came easily to him. Natural history collecting, after all, was not so very far removed from hunting: the two activities were different expressions of a single urge for possession" (p. 220).

Information for which Darwin hunted and searched, and then found and collected during the historic 1831-1836 *Beagle* voyage particularly, proved useful to him in his post-voyage publications and in informing his eventual evolutionary theory by natural selection. An 1845 letter from Darwin to David Thomas Ansted, assistant secretary of the Geological Society of London, offers an interesting example of Darwin's request for a search to be conducted by that society for previously detected and found information that had been recorded in the form of a catalogue, but which was then subsequently misplaced. It is an example that also provides a cautionary touchstone showing the importance that the organization and management of information will hold for Darwin:

> I have written to M r Lonsdale [the Geological Society's librarian] about the descriptive catalogue of Fuegian specimens.— M r . Lonsdale says he remembers well the large boxes being exposed, & that they were taken below in the crpt, & are labelled outside either "Tierra del Fuego" or "Patagonia" or "S. America" presented by either "Capt. King" or "Capt. FitzRoy". He thinks probably that the Catalogues are inside one of these boxes & on the top of the specimens. Would you be so kind as to direct Charlton [the house steward] to search for these boxes, which are large & heavy, for I well remember them.— M r . Lonsdale says that if not there, the catalogue is probably in some table-drawer or cupboard in the upper museum .— & if not there, must be together with several other catalogues, belonging to the specimens *in the upper museum*…If I cannot consult the catalogue soon, it will be useless to me" (DCOD, Letter 811, [c. January 1845]).

Darwin was hunting for the catalogue while working on his book *South America*, which Footnote 6 from the letter above states that he completed in April 1845 (DCOD, Letter 811, [*c.* January 1845]). This helps to explain Darwin's urgent search for the catalogue several months earlier.

Another brief excerpt from a letter to Darwin's friend, geologist Charles Lyell, highlights Darwin's activities related to hunting and searching for information housed in libraries: "I have not seen Naudin's paper & shall not be able till I hunt the Libraries; I am very curious to see it" (DCOD, Letter 2593, 22 [December 1859])."

2. Detecting/Finding: discovering or identifying the presence or existence of information and items.

Detecting and finding information and items were vital aspects of Darwin's information seeking process. The following letter from Darwin to botanist Joseph Dalton Hooker describes his finding of a sought-after paper:

> To prevent the possibility of your taking trouble in vain, I write to say I found Watsons Paper on Azores Plants in Lin: Soc y . yesterday, & thanks & hearty thanks to your arrangement for me, I took under Sir William's name [J.D. Hooker's father] 4 volumes home with me. (DCOD, Letter 1702, 23 [June 1855]).

Occasionally, Darwin was unable to find information himself or was unable to have others find it for him. The following letter from Charles Cardale Babington, who was a Cambridge University Professor of Botany and an expert on plant taxonomy, to Darwin illustrates an unsuccessful search for a book which Darwin was attempting to find:

> I have not been able to find any anonymous book upon Pigeons in the University Library. The word is in the Catalogue and refers to a class that has been "broken up many years since" and no trace of the book is to be found. The officials think, after consulting all the probable records in their possession that the book is not now in the library. The Catalogue does not describe the book (DCOD, Letter 1996, 22 November 1856).

Figure 6. Darwin's *Beagle* fish. Photograph taken at Museum of Zoology, Cambridge University.

Figure 7. Darwin's *Beagle* specimen containers. Photograph taken at Sedgwick Museum of Earth Sciences, Cambridge University.

3. Collecting: systematically acquiring and gathering together information and items.

Collecting is one of the behaviors most associated with Darwin. Well-known as "a beetle collector", he collected myriad organic and inorganic specimens and items throughout his life. Collecting was an activity that was close to his heart and prominent in his mind. Indeed, it is noteworthy that in the first pages of his autobiography (Barlow, 1958), written at the sunset of his life, he writes that, "The passion for collecting…was very strong in me, and was clearly innate" (p. 23). At the end of the autobiography as well, Darwin includes "collecting facts" in a short list of the characteristics that most contributed to his success (p. 145). Certainly his most prodigious period of collecting occurred during the *Beagle* voyage years of 1831-1836. As Armstrong (1985) describes:

> Throughout his travels Charles collected and observed: he collected tens of thousands of specimens of plants, insects, reptiles, mammals, molluscs, birds, rocks, fossils and minerals, and covered several thousand pages of manuscript with descriptions of the various environments he encountered. (p. 4).

At times his collecting was random during the *Beagle* voyage but most times it was purposeful. Desmond and Moore (1991) describe one of Darwin's specimen collection forays in South America, which supports this point:

> There was no blind collecting here; he was following up his Edinburgh interests. He systematically studied reproduction in encrusting sea-mats like Flustra. He uprooted a sea-pen Virgularia from the mud at Bahia Blanca and wrote page after page on the granular movement inside its stem. (p. 127).

The introduction to CCD Volume 1 also describes Darwin as "a keen and careful collector let loose in a new and challenging land" (CCD, Vol. 1, 1821-1836, pp. 3-4). It further explains that, "He was careful to collect among those groups of organisms least known in Europe, and supplemented all his collecting with extensive records and observations" (p. 4). The specimens that Darwin collected during the voyage were the impetus for a great number of post-*Beagle* published geological and zoological works "that testify to the wealth and quality of Darwin's collections and observations" (p. 4). Most significant, the introduction emphasizes that Darwin's *Beagle* collections were the foundation "for his life's work, for it was as a result of his observations and the judgements passed by systematists on some of his specimens that Darwin became a committed transmutationist a few months after his return to England" (p. 5).

In addition to geological, flora, and fauna specimens, Darwin also collected information, in the form of facts that he, and others on his behalf, gathered from books, magazine and newspaper articles, academic papers, etc. This information collecting commenced in earnest after early 1837, the introduction discusses, as Darwin had come to believe upon seeing the descriptions of some of his *Beagle* specimens that "species were mutable", and had consequently become "a transmutationist and had embarked on the long task of collecting facts and constructing theories to explain this view of the origin of species" (CCD, vol. 1, 1821-1836, p. 5).

4. Observing: watching; often taking mental and written note of things and information.

Observing, as practiced by Darwin, often went hand in hand with collecting. Returning to Darwin's autobiographical list, one of the qualities that Darwin cited as most influencing his "success as a man of science", in fact, is "industry in observing and collecting facts" (Barlow, 1958, pp. 144-145). Some researchers view Darwin's collecting and observing activities as tandem behaviors, often discussing them together, as seen in the Armstrong (1985) example (p. 4) cited in the collecting section above Observing as well as the next DIB below, i.e. Recording/note-taking. Observing and recording share some similarities but can be differentiated. Observing implies more of a mental type of behavior, conducted inside one's head, which is often but not requisitely performed in conjunction with some kind of written record of those mental images of things seen first-hand. Observing carries the sense of raw stimuli or information. Recording, on the other hand, has the connotation of a refinement of information, though this is certainly not true in all cases. Recording also implies some type of requisite writing down of those things or events which are viewed with the eyes and experienced by the senses. An 1832 letter written by Darwin to his sister, Caroline Sarah Darwin, during the *Beagle* expedition, sheds some light on how Darwin distinguished this notion of mental thoughts, observations as it were, from recorded facts and information: "I send in a packet, my commonplace Journal…Remember however this, that it is written solely to make me remember this voyage, & that it is not a record of facts but of my thoughts" (CCD, Vol. 1, 1821-1836, Letter 166, 25-26 Apr [1832], p. 226).

Darwin also refers to his observing behaviors in an 1839 letter to Alexander von Humboldt, the Prussian naturalist, geographer and traveler, whose works greatly influenced Darwin:

> I do not know, whether you are at all interested in the changes of temperature in the sea, whilst approaching land; I will, however, take the liberty of copying from my note book, some observations I made as the *Beagle* crossed the outlying shoals of the Abrolhos & approached the islands" (DCOD, Letter 545, 1 November 1839).

5. Recording/Note-taking: setting information down in writing or some other permanent form for later reference.

Figure 8. Five of Darwin's *Beagle* notebooks. Photograph taken by permission of The Home of Charles Darwin, Down House, English Heritage.

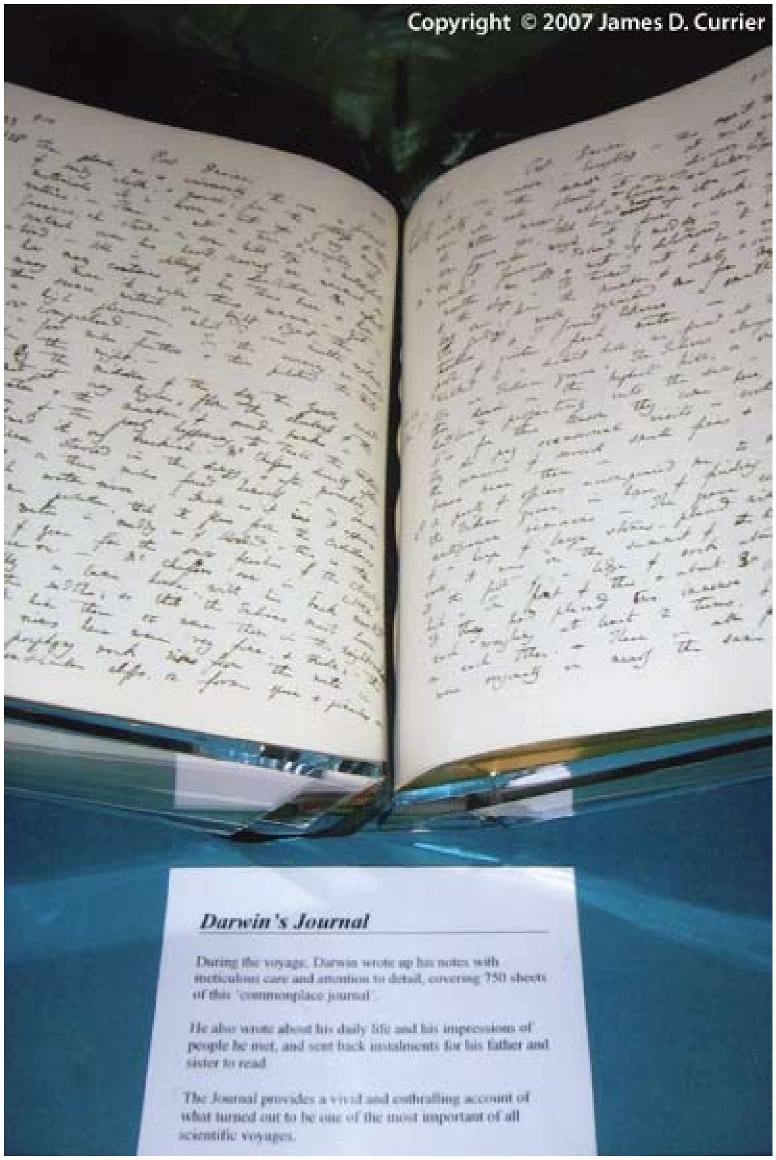

Figure 9. Facsimile of Darwin's *Beagle* journal. Photograph taken by permission of The Home of Charles Darwin, Down House, English Heritage.

Recording and note-taking were essential components of Darwin's information process. They were especially central to his broad contexts of information organizing and managing. Darwin's *Beagle* voyage notebooks and his *Beagle* journal contain the best-known examples of his recording and note-taking. A variety of Darwin's field notebooks and *Beagle* notebooks, as well as his *Beagle* journal were examined first-hand at Darwin's Down House, Cambridge University Library, and Cambridge's Sedgwick Museum of Earth Sciences and Museum of Zoology.

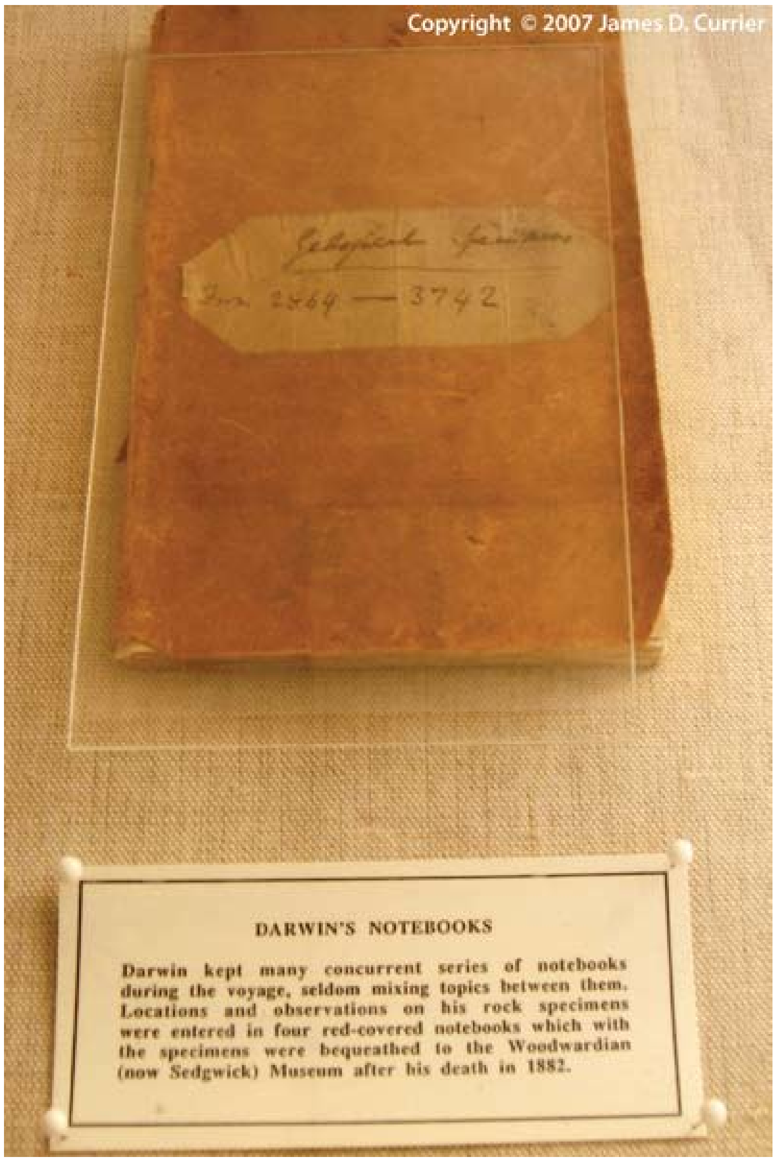

Figure 10. Darwin's Geological Specimens notebook. Photograph taken at Sedgwick Museum of Earth Sciences, Cambridge University.

On the *Beagle* voyage, Darwin recorded his raw notes in field notebooks during land expeditions. Back on board ship, he refined his notes and expanded upon his field observations. Nicholas and Nicholas (2002) provide a beneficial description of this process:

> Whenever Darwin went on an inland expedition, he carried a field notebook in which he jotted down words and phrases that formed the basis of the Diary that he kept throughout the *Beagle's* voyage. The notebook fitted conveniently into his pocket, and was always readily available for recording anything of interest. (p. 23).

Nicholas and Nicholas (2002) also note that, "By the time the *Beagle* had reached Sydney, Darwin had filled at least fourteen of these books" (p. 23). A photograph that includes the Sydney/Mauritius notebook, which Nicholas and Nicholas's (2002) book, *Charles Darwin in Australia*, discusses in detail, is included in this section.

Browne (1995) provides a helpful discussion of Darwin's various *Beagle* notebooks and other print mediums for recording (p. 194). "Darwin…composed a logbook, filling page after page of foolscap with geological observations compiled from his field notebooks while his memory was fresh" (p. 194). She explains that he also kept a logbook for zoological and botanical observations (p. 194). For these logs, Browne (1995) relates that, "details were compiled as a record which could be used by someone else: they were the information naturalists might need to identify or explain Darwin's materials" (p. 194). She explains further that, in addition to these research-oriented material, Darwin kept a diary, which she points out that he alternated between calling his "journal" or his "logbook" (p. 194). He also wrote lots of letters, many of them to his sisters (p. 194). Browne (1995) observes that the logbook served "as a repository of information that was copied out, often word for word, in long, descriptive letters to his sisters and friends" (p. 194). She asserts that Darwin learned a great deal through his writing and recording practices on the *Beagle*: "In keeping such copious records, he learned to write easily about nature and about himself" (p. 194). Through Captain Fitzroy's example, she states, Darwin learned the importance of recording information, "never relying entirely on memory and always writing reports soon after the event" (pp. 194-195).

Darwin sometimes wrote annotated comments in his field notebooks, which indicated his assessment of the information's quality that he was recording. His B. Blanca to Buenos Ayres *Beagle* field notebook provides a September 1833 example of recorded information, which was annotated as "not good information", though that evaluative comment was seemingly later struck: "Plain I should think 200 ~~or 300~~ feet above level of river; river deep rapid 12 leagues to Boca & 6 8 to Sierra. ~~not good information~~." (van Wyhe, (2005), CWCDO, Retrieved May 5, 2007, from http://darwin-online.org.uk/content/frameset?itemID=EH1.11&viewtype=text&pageseq=47&keywords=good%20information%20not, p. 32b). In contrast, this same notebook contains several notes with the annotation "good information" adjacent to them.

Darwin, a novice ship's naturalist during the *Beagle* voyage, also learned and received helpful research suggestions and how-to advice in the mail through letters from his Cambridge mentor, John Stevens Henslow, who was a botanist and mineralogist. In an 1833 letter to Darwin, Henslow provides him with some insights on recording geologic specimens: "I would not bother myself about whether I were right or wrong in noting such & such facts about Geology—note all that may be useful—most of all, the relative positions of rocks giving a little sketch thus" (CCD, Letter 196, 15 & 21 Jan [1833]). Henslow's sketch illustrating his recommended procedure is provided in CCD, Vol. 1, 1821-1836, Letter 196, p. 292. In an earlier letter, this one from 1832 and written by Darwin to Henslow, Darwin had voiced his concern about the notes he was recording: "One great source of perplexity to me is an utter ignorance whether I note the right facts & whether they are of sufficient importance to interest others" (CCD, Letter 171, Vol. 1, 1821-1836, 18 May & 16 June 1832, p. 236). A post-*Beagle* voyage letter written by Darwin in 1838 to geologist Charles Lyell offers an example of the value that Darwin's recording behaviors produced for his ongoing research and writings: "note book, after note book has been filled, with facts, which begin to group themselves *clearly* under sub-laws" (DCOD, Letter 428, [14] September [1838]). Darwin's recording and note-taking will be discussed further in sections below.

6. Annotating: adding notes to information and items in order to give explanation or comment.

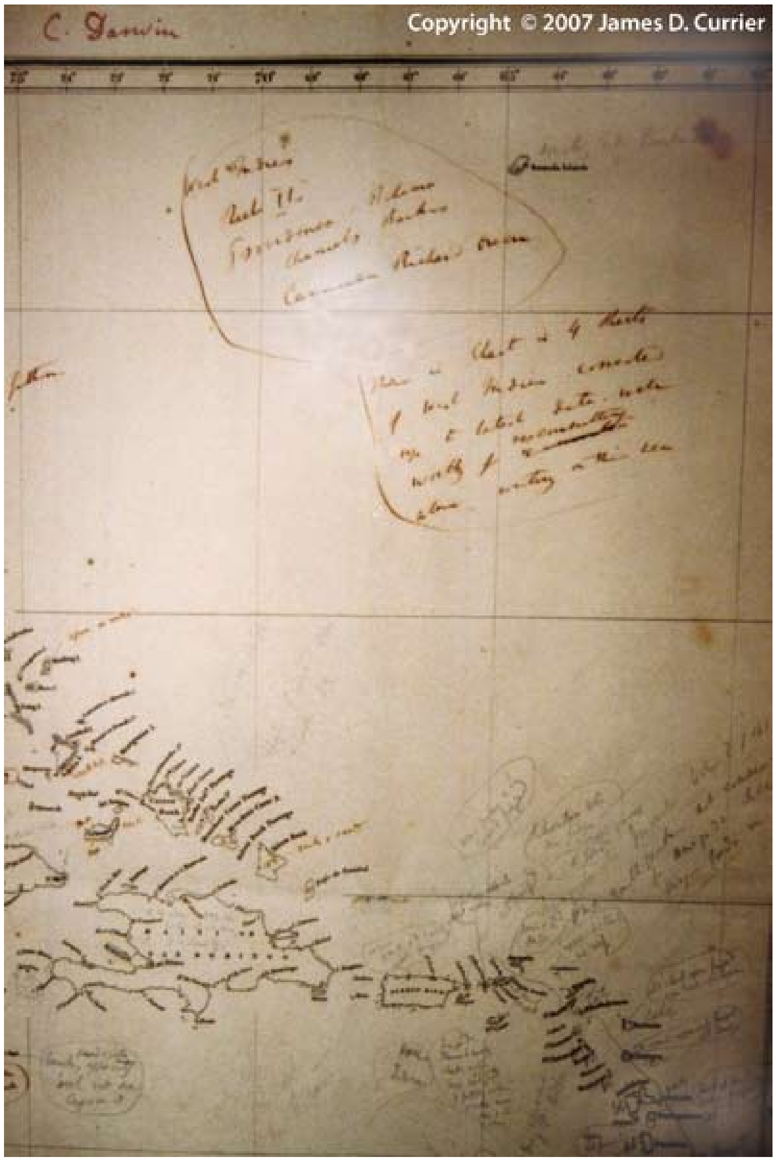

Figure 11. Darwin's annotations on wall map in Down House study. Photograph taken by permission of The Home of Charles Darwin, Down house, English Heritage.

Darwin annotated many of the books, articles, and paper documents that he read and stored for later review and potential use. Browne (2002) provides, on an unnumbered page, an image of a letter to Darwin where she notes that, "This letter shows his pencil markings and the annotation "Keep."" He used these kinds of annotated remarks as time-savers and reference points, so that he could return to his saved materials at a future time and quickly ascertain, via his previous annotations, whether and how such materials might be incorporated into works for publication. As the image included here indicates, i.e. the Caribbean/Americas map with Darwin's annotations written onto the map, he also annotated items for everyday reference and use.

An 1855 letter is a very lengthy memorandum to Darwin from Edward Blyth, a zoologist who was the curator of a museum in Calcutta, India at the time this letter was written. In the memo, Blyth provides letter extracts, references to other works, and a plethora of information on a wide range of animal species. Relevant to this discussion of Darwin's annotating behavior, Footnote 54 offers an informative example:

> On the verso of p. 2 of his abstract [of Blyth's memorandum] (DAR 203), CD commented: 'M r Blyth makes a great distinction between "Breeds" artificially made & "Races". why I know not.—' And again on p. 5: 'Blyth distinguishes Races , from *Breeds* artificially produced.— Why? (DCOD, Letter 1755, [22 Sept 1855]).

7. Abstracting: making a written summary from the contents of printed matter or information.

Abstracting was a significant means by which Darwin organized and managed the huge amounts of information that came into his possession. An 1859 letter by Darwin to geologist Charles Lyell describes Darwin's abstracting behavior:

> It was extremely kind of you to take so much trouble to tell me about Haldeman's paper, which I read several years ago & abstracted, & I have just looked at my abstract. I well remember thinking it a very clever paper; but I did not find much of any actual use to me. I think I have quoted him in my large Book about ranges of varieties; but in my present condensed volume, I have not alluded to the paper. The speculations approach mine & Wallace's, but did not on any point seem to me identical. (DCOD, Letter 2470, 21 June [1859]).

Footnote 2 notes that, "CD had read…Haldeman's paper [which] discussed the geographical distribution of species…[and that] CD's abstract of this paper is in DAR 74: 163–4. He cited it in *Natural selection*, p. 116, in his chapter on variation under nature" (DCOD, Letter 2470, Footnote 2, 21 June [1859]).

8. Borrowing: taking and using printed information or objects that belong to another, with the intention of returning them.

Libraries were invaluable as repositories of print resources that facilitated Darwin's acquisition of information throughout his life. Darwin was thrifty by nature, so borrowing the books and materials he desired and needed held special appeal. Such materials were not only housed in traditional brick and mortar libraries, as principally pictured today when thinking about libraries, but also in private homes, where learned, affluent persons often maintained their own collections of books and journals. Darwin was very comfortable with requesting and borrowing books from his friends and peers: "I shall be very glad to borrow Heer [1855], when you go abroad" (DCOD, Letter 1866, CD to Charles Lyell, 3 May [1856]).

Darwin's membership in learned societies and professional clubs, as well as friendships and acquaintance with scientific peers, aided his print borrowing habits. Fortuitously for Darwin, as an example, Joseph Dalton Hooker's father was the curator of the Royal Botanical Gardens at Kew. This afforded a convenient means for accessing and borrowing its wealth of authoritative resources, as this letter from Darwin to J.D. Hooker shows:

> In my last letter I said I had not read your Coal Paper, because I had not yet borrowed the Volume: that same evening lo & behold I found your Paper amongst my Books: when starting & packing for this place I received the parcel from your Father & somehow overlooked the Coal Paper in a manner, which I cannot even now understand. I have read it with the *greatest* interest. (DCOD, Letter 1239, 9 April 1849).

Darwin's association with Hooker and his father also enabled him to sometimes bend the rules vis-à-vis borrowing restrictions, as this letter from Darwin to Hooker and an editorial footnote afterwards explains:

> To prevent the possibility of your taking trouble in vain, I write to say I found Watsons Paper on Azores Plants [Watson 1843–4 and Watson 1847] in Lin: Soc y . yesterday, & thanks & hearty thanks to your arrangement for me, I took under Sir William's name 4 volumes home with me. (DCOD, Letter 1702, 23 [June 1855]).

Footnote 2 states that, "Hooker had arranged to let CD borrow books from the Linnean Society in his name and that of his father, William Jackson Hooker, because Richard Kippist, the librarian, was reluctant to allow CD to borrow more than the number permitted to CD as a fellow" (DCOD, Letter 1702, 23 [June 1855]).

Darwin's time on the *Beagle* instilled in him the value of a good library. Indeed, books were his roommates; his shared poop cabin also housed the *Beagle*'s library, arranged around the sides of the cabin. Herbert (2005) describes the library as "well-stocked" and "well-run" (p. 50). She explains that "Somewhere between 245 and 275 volumes are known to have been on board" (p. 50). The library comprised subject monographs, technical works, introductory scientific texts, personal exploratory narratives and travelogues, oceanic surveys, histories, dictionaries, atlases, and fiction, such as Milton's *Paradise Lost* (CCD, Volume 1, 1821-1836, pp. 558-566). The *Beagle*'s Captain Robert Fitzroy had in fact written to Darwin before the ship sailed, to say that Darwin was "of course welcome to take your Humboldt—as well as any other books you like" and that, "There will be *plenty* of room for Books" (CCD, Letter 135, 23 September 1831). CCD's Volume 1, 1821-1836, contains Appendix IV: The books on board the *Beagle* (p. 553). A diagram of the small poop cabin and library is provided, depicting the bookcases in an L-shape encircling half of the cabin's 10 feet by 11 feet space (p. 553). A set of eight regulations governing the library is extant (p. 554). The regulations cover issues related to borrowing, lending, returning, protection/preservation of the books, as well as the library's catalogues. Regulation 4 requires that: "Two Catalogues will be kept, one for general use, the other for the Cabin" (p. 554). Unfortunately, the appendix reports that these two catalogues have not survived (p. 554). Hence, researchers have employed other extant evidentiary sources to reconstruct the *Beagle*'s library contents, some of which have been conjectured, in order "to compile a list of works used by CD during the voyage" (pp. 554, 558-566). The appendix notes that books used by Darwin were his own "but the majority were probably part of the *Beagle* library" (p. 554).

9. Lending: granting another the use of printed information or objects with the understanding that they will be returned.

Lending is the related flipside to borrowing activity, but it is covered separately in this dissertation to highlight a few nuances and distinctions in Darwin's correspondence. The following letter excerpt by Darwin to Edward William Vernon Harcourt, a politician who had studied the natural history of Madeira, illustrates one of Darwin's book lending requests:

> I think you told me long ago that you had Brehm's Book on German ornithology. If this be so, & you can spare it, will you be so kind as to lend it me for a fortnight.— In this case will you put on enclosed address & send it by Parcels Deliv. Co y . (DCOD, Letter 1451, 19 August [1856]).

Footnote 3 states that, "CD had skimmed Christian Ludwig Brehm's work ten years earlier and was aware of his tendency to split species (*Correspondence* vol. 3, letter to Leonard Jenyns, 17 October [1846])" (DCOD, Letter 1451, 19 August [1856]).

Securing loans of print materials from his peers was especially important to Darwin when he could not obtain access to institutional or organizational collections, as this example regarding the Linnean Society's library describes:

> If at home & you can find time, I sh d . be very glad of the Books, (Koch or Ledebour, or Webb or anything) in which varieties are marked to tabulate them. Can you at same time lend me the Cybele Brit. [Watson 1847-59] as Linn. Soc y . is closed. (DCOD, Letter 2137, 6 September [1857]).

Another reason to delineate borrowing from lending is to show that Darwin was also a loaner of his materials to others. This excerpt from an 1845 letter by Darwin to Christian Gottfried

Ehrenberg, a German zoologist, exposes Darwin's pique at the failure of a mutual colleague to return several of Darwin's loaned items:

> I beg to apologise for having thus troubled you, but might I further request you, should you see Dr . Dieffenbach, kindly to take the trouble to ask him, to return me my copper-plate, woodcuts, & M.S. corrections for his German edition of my Journal, which I cannot get him to return to me. (DCOD, Letter 819, 23 January [1845]).

The following 1859 letter from Darwin to his botanist friend, Joseph Dalton Hooker, highlights how routine the loaning of materials to Darwin by his peers had become, and upon which he greatly relied:

> I never thought about the Book belonging to the Public Library.— [Footnote 1 explains that, "The 'Public Library' was the collection of books belonging to the Royal Botanic Gardens, Kew.] It is extra-ordinarily kind of Sir William letting me have Books: on some former occasions I do not know what I could have done without this great kindness. I will return it next week, by the Carrier & from London by Parcels delivery, which I sh d think was very safe channel. (DCOD, Letter 2602, 25 [December 1859]).

Footnote 2 explains that, "William Jackson Hooker had often lent CD works from the Hookers' private library and from Kew when he was preparing his species manuscript" (DCOD, Letter 2602, Footnote 2, 25 [December 1859]).

10. Questioning/Asking: saying something, posing a question, or making a request in order to obtain an answer or information.

Many of Darwin's letters included questions posed by Darwin to his correspondents. Occasionally he also asked correspondents to pose questions to other persons and relay their responses back, on Darwin's behalf. He was egalitarian in his questioning, making queries of people from all walks of life. Browne (1995) explains that while investigating species transmutation, Darwin often asked questions of friends, relatives, and working persons with whom he came into contact (p. 365). His questions never dealt specifically with evolution, which he kept hidden, but rather more general topics pertaining to flora and fauna (p. 365). Browne offers some illustrative instances:

> [Darwin] asked Mark, Dr. Darwin's coachman, for his opinion on dogs, and Thomas Eyton for his views on owls and pigs. He made Fox struggle with a deluge of farmyard questions of all shapes and sizes. He struck up a correspondence with his Uncle Jos [Wedgwood] about Staffordshire worms. When Darwin then discovered that his London hairdresser was interested in pedigree hounds, Mr. Willis of Great Marlborough Street appeared, just like the others, in his notebooks as a source of information about dog breeding. (p. 365).

Darwin sometimes asked his questions orally and at other times in writing. The following example shows how Darwin sometimes used written questionnaires to pose questions. In this 1839 instance, Darwin asked several animal breeders to answer twenty-one questions that he submitted to them on a printed questionnaire entitled "Questions about the Breeding of Animals." CCD vol. 2, 1837-1843, describes the questionnaire: "The questionnaire was signed and distributed by CD from 12 Upper Gower Street [London], and consists of eight quarto pages. The type runs down the inside half of each page, thereby leaving a blank column for answers to be inserted" (p. 446). He received 2 replies: one dated [10 May 1839] from George Tollet, an animal breeder, and the other dated 6 May 1839 from Richard Sutton Ford, who was also an animal breeder; Tollet's answers "are the only extant replies actually written on the questionnaire" (DCOD, Letter 510, 510.f1). CCD, vol. 2, 1837-1843, Appendix V provides Darwin's "Questions about the Breeding of Animals" (p. 446). Part of question 21 specifies that, "All information is valuable, regarding any crosses whatever, between different wild animals, either free or in confinement, or between them and the domesticated kinds;" (CCD vol. 2, 1837-1843, Appendix V, p. 449).

11. Pumping: persistent questioning with the aim of eliciting and attaining all possible information or items from someone.

Darwin sometimes engaged in a more persistent form of questioning with his peers and other information sources. He referred to this behavior as 'pumping' (Desmond & Moore, 1991, p. 325). Botanist Joseph Dalton Hooker was one of the most frequent recipients of Darwin's pumping. Desmond and Moore (1991) describe an instance that illustrates this information behavior well:

> He came to rely on [Hooker's] help, constantly inviting Hooker to Down, almost to the point of pestering him…On his first visit…Darwin picked his brains on island floras, milking him mercilessly—'pumping' he called it—and it became a regular feature of their get-togethers. After breakfast he would take Hooker into the study for twenty minutes and bring out a list of questions. Some Hooker answered on the spot, a few required consideration, and others protracted research in Kew Gardens. The answers came on slips of paper, which Darwin deposited in pockets that hung against the study wall near his chair, each one devoted to a special topic. (p. 325).

Hooker also used the term to describe his own behavior, as shown in an 1848 letter when he tells Darwin that "I have been pumping Hodgson for you; & he has given me for you a set of his Zoological pamphlets which I will send to my Father for you" (DCOD, Letter 1203, 13 Oct 1848). In another instance, Darwin refers to this type of persistent questioning by another term—'screwing knowledge out of'—which is evinced in an 1845 letter to Hooker, where he states, "I shall keep some memoranda hereafter to screw knowledge out of you" (DCOD, Letter 847, 31 March [1845]). An equal opportunity 'pumper' of information, Darwin, in an 1857 letter to his cousin, William Darwin Fox, unabashedly writes that, "I work all my friends" (DCOD, Letter 2049, 8 Feb [1857]). In a final excerpted example from 1859, Darwin amusingly "fesses up" to the information pumping behavior that he has used on his friend Joseph Dalton Hooker for many years at this point, while expressing its great value to him:

> I never did pick anybody's pocket, but whilst writing my present chapter I keep on feeling, (even when differing most from you!) just as if I were stealing from you, so much do I owe to your writings & conversations; so much more than mere acknowledgments show. (DCOD, Letter 2406, 28 January [1859]).

12. Giving/Supplying: making needed or wanted information or things available to another, typically by gratis and permanent transfer of possession.

In addition to asking people for loans of information and objects, Darwin also sought information and specimens that could be given or supplied to him for keeping and using on a permanent basis. Joseph Dalton Hooker exemplifies the kind of Darwin source who freely gave and supplied him with information; as Desmond and Moore (1991) cite, 'content to be a gatherer of facts for you', Hooker wrote to Darwin (p. 325).

By the same token, Darwin also sometimes gave specimens and print materials to others, thereby fostering reciprocal relationships for supplying and receiving information. An 1849 letter from Darwin to James Dwight Dana, an American geologist and zoologist who was also a Yale University professor of natural history and an editor of *The American Journal of Science and Arts*, keenly demonstrates (1) Darwin's seeking of a supply of specimens, and (2) his cultivation of Dana for his global network of information providers, which will be discussed in the section on corresponding below:

> When I meet a very goodnatured man, I have that degree of badness of disposition in me, that I always endeavour to take advantage of him: therefore I am going to mention some desiderata, which if you can supply I shall be very grateful, *but if not no answer will be required*. I want much a specimen of Coronula denticulata of Say on the Kings Crab of U. States…(of course I w d . return any specimens only lent me, only I require to open one specimen of each kind). (DCOD, Letter 1276, 5 December [1849]).

13. Procuring: obtaining, often via purchase, information and items first-hand or through another party.

Many of the items and much of the information that Darwin sought and attained came via his own hands or through loans from others. However, information that he was unable to acquire for free or borrow on his own had to be procured or purchased. A number of instances depicting Darwin's procuring activities were identified for this dissertation's proposal, chiefly from his five years on the *Beagle*, where procurement was the principal means by which the far-from-home ship's naturalist was able to acquire reading and writing materials and other supplies. Several additional letters cited below show the kinds of information-related procuring activities engaged in by Darwin.

> Letter 1263, CD to Swale and Wilson, [on or before 24 October 1849]: "Will you please to send to address on other page by next Wednesday night,— Footprints of a Creator (by H. Miller) —— Humboldts letters of a Statesman *translated* recently—— Six cards of " *Patent Parryian National Pen No r 3.: Fine Points* " And a packet of 100 of Newspaper covers; I think patented by Delafield—viz a strip of paper with a tape let in." As an aside, footnote 6 explicates that the requested newspaper covers were "Wrappers used for forwarding newspapers and magazines through the post" (DCOD, Letter 1263, [on or before 24 October 1849]). Footnote 1 of this letter also explains that Swale and Wilson, the "conjectured recipients" of this letter "were [London] publishers, general stationers, and news vendors" (DCOD, Letter 1263, [on or before 24 October 1849]).

The calendar summary of an 1866 letter from Darwin to Williams & Norgate, London booksellers and publishers, from whom a number of instances show Darwin made book and journal orders, notes that Darwin "Orders Richard Owen's Anatomy of vertebrates [1866-8],… subscribes to Annals and Magazine of Natural History,…and orders three back numbers of Medical Times and Gazette" (DCOD, Letter 5002, 10 Feb [1866]).

In keeping with the reciprocal relationships of supplying and receiving which Darwin fostered with his peers, an 1849 letter from Darwin to James Dwight Dana describes the former's efforts to procure items that Dana desired:

> I have been endeavouring to get the papers &c, which you want. I have procured the 4 first Parts of Thompson Researches; the 5 th part has been lost, & even the Publisher knows not how;—this I hope you will allow me to give you.— Professor Bell has sent me for you copies of all his Papers; I have applied elsewhere, but whether I shall succeed I know not. In the course of two or three

> weeks I will send all off to you through Delf— I will gratify myself by including copies of several Geolog. papers of my own. (DCOD, Letter 1276, 5 Dec [1849]).

A bit further in the 1849 letter cited above, Darwin's request to Dana to procure him a list, illustrates the reciprocal nature of the peer relationships within which Darwin adroitly engaged: "Lastly can you tell me whether any list has been published of the plants found on **Elevated** coral islands; or could you procure me such a list" (DCOD, Letter 1276, 5 Dec [1849]).

The last line of the passage cited above, in which Darwin casually mentions that he will be sending some of his papers to the American geologist/zoologist Dana, shows the clever, deft manner in which Darwin facilitated the dispersal and dissemination of his scientific ideas. This information behavior of 'dispersing' will be examined below in greater detail.

14. Corresponding: communicating information by exchanging written letters, typically delivered through the postal service.

Figure 12. Darwin's letters and letter writing pad. Photograph taken by permission of The Home of Charles Darwin, Down House, English Heritage.

Corresponding was one of the farthest-reaching, fruitful information behaviors engaged in by Darwin. In an unnumbered section of images displayed in Browne's (2002) *Charles Darwin: The Power of Place*, she notes that, "Darwin's correspondence was a key research tool", and that, "The efficiency of the Victorian postal system made it possible for Darwin to develop an extensive correspondence network". Corresponding had especially been imprinted upon Darwin as a vital means for information transmission and delivery during his five isolated years on the *Beagle*. Mail—in the form of letters, casks of specimens, journals, etc.—sent by Darwin to England, and, alternately, mail retrieved by him when the *Beagle* made ports of call, provided access to a trans-oceanic pipeline conveying news and varied print information resources. A memorandum written by Darwin in December 1855 vividly highlights the globe-spanning scope of the network of information correspondents he was cultivating (CCD, Vol. 1, 1851-1855, [December 1855], (p. 510). At this time Darwin was studying differences in the varieties of domestic animal species. The 1855 memo states that Darwin is seeking "Skins Any domestic breed or race, of Poultry, Pigeons, Rabbits, Cats, & even dogs, if not too large, which has been bred for many generations in any little visited region , would be of great value" (p. 510). Darwin then records the names and locations of the persons to whom he has written for pigeon and poultry skins. The venues encompass the Earth: Jamaica and Antigua in the Caribbean, Panama and South America of the mainland Americas, east to tiny Ascension Island at the mid-point between South America and Africa, onward to Africa's Cape of Good Hope, west to Gambia, and north to Tunis, then eastward to Persia, Ceylon, Bombay, Calcutta, Ceylon, Hong Kong, and Shanghai. Of particular historical note is one of the correspondents named Alfred Russel Wallace, listed in this memo as "R. Wallace", who sent specimens to Darwin from the Malay Archipelago. His unique impact on Darwin's information behaviors will be explored in the case study below.

An excerpt from a letter by Darwin to Henry Norton Shaw, Secretary to the Royal Geographical Society, dated around the same time as this 1855 memo, provides an informative example of the ways Darwin continued to strive to add to his burgeoning global information network of correspondents, filling in geographical gaps with new correspondents: "I have now written to each chief quarter of the world, except Arabia. Can you aid me here; being so anciently civilised it w d . be very fine region for me. Is there any semi-scientific man in Aden?" (DCOD, Letter 1800, 25 December [1855]). In this letter as well, Darwin asks if Norton can recommend someone in Angola who can provide some skins and says that he has someone to help him cover East Africa. Just six months later Darwin's globally-cast net is beginning to yield a substantial haul. In a June 1856 letter to William Darwin Fox, he writes that:

> I have been working of late very hard & have now an enormous correspondence.— I think I shall make an interesting collection of domestic Vars. for promises are coming in from all quarters. This morning I heard from Rajah Brooke [of Borneo] with promises of energetic assistance. and Hon bl . Ch. Murray says Pigeons & Fowls are on their road for me from Persia, —as are others from E. Africa. (DCOD, Letter 1895, 8 [June 1856]).

Desmond and Moore (1991), moreover, chronicle the network's ascendant position by the late 1860's: "Down House had become the hub of a correspondence network across the Empire, its tentacles touching every little England" (p. 565). Correspondents from former British colonies, such as the U.S., and those from nations outside the United Kingdom's sphere were certainly important to the network as well. But Britain's strategic colonial footholds and trading partners around the globe provided Darwin with unparalleled opportunities for planet-wide information access:

> Botanists from Ceylon to Calcutta sent reports on monkey manes and bearded Indians; engineers from Malacca to Nicaragua told of indigenous customs; tile manufacturers in Gibraltar attended to merino lambs; wine exporters in Portugal followed the local tailless dogs; Laplanders measured reindeer horns; New Zealanders heroically tackled the Maori's sense of beauty; and missionaries and magistrates from Queensland to Victoria ceased converting and incarcerating to observe aboriginal ways—with even an old *Beagle* shipmate Philip King helping out. This is what Darwin excelled at: collecting and collating, tracking down facts, verifying, extending his old notebook speculations to embrace the globe. (Desmond & Moore, 1991, p. 565).

Of course, there were downsides to corresponding too. In an 1850 letter by Darwin to Albany Hancock, a zoologist and paleontologist, he opines, "How difficult it is to discuss any point by letter", having noticed that he had neglected to mention an observation to Hancock (DCOD, Letter 1311, [26 January-March 1850]). This point provides an opportune segue to the next DIB of face-to-face networking.

15. Face-to-face networking: interacting in person with people at a venue, where the exchange of information and development of contacts can occur.

Much of Darwin's information acquisition in the latter part of his life occurred through correspondence, owing in large part to Darwin's relative seclusion at Down House arising from chronic health issues. However, several instances identified in this dissertation highlight the value of face-to-face networking for Darwin. Attendance at professional meetings in London gave Darwin the chance to talk in person with scientific friends and peers, as his letter to Thomas Henry Huxley shows: "I missed you at the Club for a scientific jaw, though I had very pleasant evening, luckily sitting by Hooker" (DCOD, Letter 2224, 24 February [1858]). Footnote 6 indicates that, "CD refers to the meeting of the Philosophical Club of the Royal Society on 18 February, which both he and Joseph Dalton Hooker attended" (DCOD, Letter 2224, 24 February [1858]).

In addition to networking with peers, Browne (1995) explains that, "When seeking information on any new topic, he learned to go straight to the breeders and gardeners, the zookeepers, Highland ghillies, and pigeon fanciers of Victorian Britain" (p. 365). Darwin perceived these persons as having "great practical expertise" but not interested "in pursuing larger theoretical explanations", and, hence, they were not a threat to his ambitions (p. 365). His social status was an issue in such interactions. As Browne writes:

> Being a gentleman—being able to use his social position to draw out material from people rarely considered scientific authorities in their own right—was important. His notebooks began bulging with details methodically appropriated from a world of expertise normally kept separate from high science. (p. 365).

The following example articulates the value that Darwin perceived that he derived through this kind of direct interfacing. An 1859 letter by Darwin to zoologist Thomas Henry Huxley describes his networking behaviors:

> I have found it very important associating with fanciers & breeders.— For instance I sat one evening in a gin-palace in the Borough amongst a set of Pigeon-fanciers,—when it was hinted that M r Bult had crossed his Powters with Runts to gain size; & if you had seen the solemn, the mysterious & awful shakes of the head which all the fanciers gave at this scandalous proceeding, you would have recognised how little crossing has had to do with improving breeds, & how dangerous for endless generations the process was.— All this was brought home far more vividly than by pages of mere statements &c— But I am scribbling foolishly. I really do not know how to advise about getting up facts on breeding & improving breeds— Go to shows is one way— Read *all* treatise on any one domestic animal & believe nothing without largely confirmed.— For your lecture I can give you a few amusing anecdotes & sentences, if you want to make audience laugh. (DCOD, Letter 2558, 27 November [1859]).

Footnote 7 says that, "CD refers to Benjamin Edmund Bult, pigeon-fancier and member of the Philoperisteron Society, of which CD was also a member. For CD's participation in the pigeon-fanciers' clubs of London, see *Correspondence* vol. 5, letter to W. E. Darwin, 29 [November 1856], and also Secord 1981." (DCOD, Letter 2558, 27 November [1859]).

16. Delegating: assigning and entrusting an information-related task or responsibility to another person, typically someone who is less senior or in the delegator's employ.

Darwin's comfortable financial status afforded him the enviable ability to employ assistants and servants throughout his life. This gave him a considerable advantage with regard to prioritizing his time and work. Servants in the Darwin family employ during the Down House years performed household and maintenance duties. He also periodically delegated a variety of information-related tasks to them. Examples included enlisting their help with his experiments, or hiring individuals on a part-time or full-time basis to perform various information tasks of a repetitive, non-creative nature. While living at Down House, for instance, Darwin routinely utilized three Downe village schoolteachers as copyists of his catalogues, manuscripts, and so forth. DCOD, Letter 2455's Footnote 1 states that, "CD's copyists were Mr. Fletcher, John Mumford, and Ebenezer Norman." In that letter, dated 29 April [1859], Darwin informs his London publisher John Murray that the death of a family member of one of his copyists "has delayed the copying of two chapters [of *Origin*]", showing another type of information task, which Darwin delegated (DCOD, Letter 2455, 29 April [1859]). A month before that, Darwin had written to Murray, reporting that:

> I am glad to say that my copyists have been diligent & I find I shall be able to send you by Post in 3 or 4 days, the Title (with some remarks for your consideration) the short Introduction,— Ch. I. & Ch II (short but dryest in volume) & Ch. III. In about 8 or 9 days from now I shall be able to send Ch. IV & Ch X & XI. (DCOD, Letter 2445, 2 April [1859]).

In an 1858 letter, Darwin tells Hooker it would be a waste of the latter's time to tabulate botanical varieties, "for I can get the Down schoolmaster [Ebenezer Norman] to do it on my return & can tell you all results" (DCOD, Letter 2306, 13 [July 1858]). Darwin's words indicate a prioritization of various tasks, with the sense that those of a rote nature could and should be farmed out to others. About a year earlier, Darwin had written to Hooker, thanking him for a loan of books from which the tabulations could be made (DCOD, Letter 2140, 11 September [1857]). He says that, "I shall not, of course, try to do all, but will invest a handsome sum with our Schoolmaster" (DCOD, Letter 2140, 11 September [1857]). Footnote 3 explains that, "Ebenezer Norman made extensive tabulations from the books sent by Hooker during the last quarter of 1857" (DCOD, Letter 2140, Footnote 3,11 September [1857])

During the *Beagle* voyage, Darwin's physician father, Dr. Robert Waring Darwin, permitted him to hire a member of the crew, Syms Covington, to assist with his ship's naturalist responsibilities and to whom he delegated some of his information-related tasks. Covington frequently went ashore with Darwin and helped him to collect specimens and perform errands, like picking up supplies. Covington continued to assist Darwin after their return to England in 1836. He eventually emigrated to New South Wales, Australia in 1839 and started a family there. Darwin and Covington maintained contact by correspondence. In response to ongoing Darwin's requests for specimens, such as barnacles during his eight-year classification work on *cirripedes*, the former servant/assistant-cum-Australian postmaster continued "to collect in the colony—which he did expertly" (Browne, 1995, p. 367) and send specimens back to his former employer, until Covington's death in 1861.

The following footnote from an 1839 letter sent by Darwin to William Herbert, a naturalist and clergyman, provides a good illustration of the kinds of tasks which Darwin delegated to persons, such as Syms Covington. In this instance, Darwin enlisted Covington's help in finalizing a set of botanical questions to be sent to Herbert:

> The draft, in Syms Covington's hand, originally had a heading 'Questions for M r Herbert'. It was deleted by CD in ink similar to that of the other alterations he made throughout the draft (see Manuscript Alterations and Comments). At the end of the draft CD added in pencil: Covington Copy these questions on a sheet of paper but leave a narrow margin, & make each paragraph with the numbers begin a fresh line.— Will you let me have them by ten oclock tomorrow. (DCOD, Letter 502, Footnote 2, [c. 1 April 1839]).

Darwin also delegated other kinds of information-related tasks, such as the conducting of experiments, to people who were not in his employ. The following example from a letter by Darwin to John Lindley, who was a botanist and librarian, offers an example:

> I take the liberty, at the suggestion of D r . Royle, of forwarding to you a few seeds, which have been found under very singular circumstances…I hope you will not think me troublesome in asking you to have these seeds carefully planted & in begging you so far to oblige me as to take the trouble to inform me of the result… M r Kemp is anxious to publish an account of his discovery himself, so perhaps you will be so kind as to communicate the result to me & not through any periodical. (DCOD, Letter 668, 8 [April 1843]).

Darwin sometimes delegated information-related tasks to family members. A number of letters indicate that Emma, Darwin's sister, and eventually his adult children assisted him in editing his writings and performing other tasks related to the organization and management of his print resources and physical specimens.

17. Packaging: placing objects or information inside some type of physical material, for purposes of delivery, storage, preservation, borrowing, lending, or sale.

Figure 13. Darwin's packets for sand from *Beagle* voyage. Photograph taken at Sedgwick Museum of Earth Sciences, Cambridge University.

As with recording/note-taking discussed above, the following letter from Darwin's mentor, John Stevens Henslow, presents an informative example regarding packaging.

Darwin's packaging of the specimens he collected during the *Beagle* expedition to send back to England was critically important. To that end, the excerpted letter cited below is representative of the kinds of feedback and advice given to Darwin by Henslow and others by means of letters while he was on the *Beagle* voyage. Suggestions, like those referenced below, from his mentor Henslow may have informed his scientific development and information behaviors:

> Letter 196, John Stevens Henslow to CD, 15 & 21 Jan [1833]: "I will tell now for the Box <of specimens Darwin had sent back to England>--Lowe *underpacks* Darwin *overpacks*—The latter is in fault on the right side. You need not make so great a parade of tow & paper for the geolog<ic> specimens, as they travel very well provided they be each wrapped up *German fashion* & closely stowed—but *above all things* don't put tow round *any thing* before you have first wrapped it up in a piece of thin paper—It is impossible to clear away the fibres of the tow from some of your specimens without injuring them—An excellent crab has lost all its legs, & an Echinus ½ its spines by this error. I don't think however than any other specimens besides these 2 have been at all injured" (CCD, Vol. 1, 1821-1836, p. 293).

18. Transmitting/Delivering: sending information and items by water or land transportation, typically through third parties.

Figure 14. Barrel for transmitting Darwin's *Beagle* specimens to England. Photograph taken by permission of The Home of Charles Darwin, Down House, English Heritage.

The transmission and delivery of information and items was also important to Darwin's information behaviors. As discussed previously with regard to packaging, transmitting

Darwin's packaged specimens from the *Beagle*'s ports of call back to England was integral to his post-voyage work. That work was focused on the cataloguing of his voluminous specimens by Cambridge flora, fauna, and geological subject specialists, such as John Gould on his birds, which enabled him to eventually write about and publish those specimen descriptions. Desmond and Moore (1991) describe Darwin's shipping off to England from South America "his first box of specimens to Henslow, who would store them for his return" (p. 127). They also discuss Darwin's hard work in shipping additional specimens from Montevideo: "two large casks of fossil bones and a small one with skins, beetles, and pickled fish went off to Henslow on the 24th, two days before they sailed" (p. 131).

The delivery of information and items to Darwin on the *Beagle* from his family and peers back in England was also crucial to his ability to perform information-related activities like collecting, recording/note-taking, observing, reading, referencing, and more. The next letter by Darwin to his mentor, John Stevens Henslow, succinctly depicts information transmission's importance for Darwin after his return to England too:

> My message to L. Jenyns, is simply that I expect T. Eyton to pay me a visit before long, when he comes up to town, & that the fish [i.e. Darwin's *Beagle*-caught fish specimens] had better be sent soon by waggon to 36 Great Marlborough St. (DCOD, Letter 384, [4 November 1837].

19. Skimming/Browsing: visual scanning of written materials quickly or cursorily to gain an impression of the contents.

As customary for most people who read, Darwin read print materials for varied purposes and with different degrees of attention, e.g. skimming or browsing, reading thoroughly, and referencing. What was not typical, however, was that Darwin kept well-detailed lists of the books he had read, accompanied by notes specifying the level of scrutiny with which they had been read. Darwin's reading notebooks, which will be discussed in the listing behaviors section below, offer an excellent example of Darwin's skimming/browsing behavior. In a reading notebook section titled "Books Read, 1838-51", two books included in a passage for October 1838 demonstrate how Darwin distinguished and annotated his reading practices:

1838

Oct…

Oct 12th Kotzebue's two voyages [Kotzebue 1821 and 1830]—skimmed well

Lutke's voyage [Lutke 1835-6]—carefully read

(CCD, Vol. 4, 1847-1850, Appendix IV, Reading Notebooks, p. 456).

An 1846 letter from Darwin to Joseph Dalton Hooker shows that on some occasions a more through reading of a book by Darwin, and its attendant annotation by him, enabled him to skim it at a later time when he might then elect to use that particular source in a work:

> I have at last finished Webb & Berthelot [1836–50, vol. 3, pt 1], & carefully packed it up; shall I return it you or keep it? If you will be so good as to leave my few pencil marks (that I may hereafter skim through it) it is absolutely the same to me whether returned now or hereafter. (DCOD, Letter 945, [31 January 1846]).

20. Reading: viewing and comprehending the meaning of information via written or printed sources, typically of more duration than skimming and browsing.

Darwin was an avid reader his entire life. His fiction reading was eclectic: "He favored junky romantic novels with pretty heroines and happy endings, but he also enjoyed *Adam Bede*" (Quammen, 2006, pp. 167-168). During the *Beagle* years, long times at sea afforded him plenty of time and a hearty appetite for reading but proportionately fewer offerings from which to choose in the *Beagle* library than he desired, as this excerpt from Darwin to his sister, Caroline Sarah Darwin, shows: "Before leaving Rio I shall send a begging letter for some books (the enjoyment of which is immense)" (CCD, Vol. 1, 1821-1836, Letter 164, [2] & 5 & 6 Apr [1832], p. 221). As discussed earlier, Darwin's older brother, Erasmus, frequently was asked to procure books and supplies to send to Darwin during the *Beagle* voyage. In a letter to another sister, Catherine, spelling out specific books that Darwin wanted their brother Erasmus to get and send to him, the value that books held for him was keenly apparent: "You cannot imagine what a miser-like value is attached to books, when incapable of procuring them" (CCD, Vol. 1, 1821-1836, Letter 176, CD to Emily Catherine Darwin, 5 July [1832], p. 247).

Books also were important to Darwin as information sources. Some books were especially influential upon his thinking and development, such as volume one of geologist Charles Lyell's 3-volume *Principles of Geology* (1830-33), which had been given to Darwin as a gift by the *Beagle*'s Captain Fitzroy before their departure from England. After Darwin returned from the voyage, Lyell would eventually become one of Darwin's most important scientific peers, confidantes, and friends. As a result of reading volume one, Desmond and Moore (1991) write, "Darwin seemed to view the world as slowly and gradually changing" (p. 118). Browne (1995) expounds:

> The theories of Charles Lyell, as put forward in his *Principles of Geology* (1830-1833), were…central to all his other activities during the rest of the voyage. In one of the most remarkable interchanges in the history of science, Lyell's book taught Darwin how to think about nature. Without Lyell there would have been no Darwin: no intellectual journey, no voyage of the *Beagle* as commonly understood. His influence—and his impact—on the young traveler can hardly be overestimated. (p. 186).

Highlighting, again, the significant information transmission capabilities even in this 19th century age, dependent upon steam and coal-fired ships and trains, and horse-drawn carriages for transport and delivery of goods, Darwin was able to attain volumes two and three of Lyell's series, following requests for them which had been mailed to his family and scientific colleagues back in England. "He made sure he acquired the next two volumes of the *Principles* during the course of the voyage", Browne (1995) relates, "and worked eagerly to understand the world as if he were Lyell" (p. 189). He did not agree with everything that Lyell espoused and wrote, but Lyell's ideas in the *Principles* were "food for thought" (Desmond & Moore, 1991, p. 131).

Back on land in England after the voyage's completion in 1836, reading continued to be a significant activity for Darwin as he reviewed his myriad notes on the specimens that he had encountered and collected, in preparation for publication. This excerpt from an 1837 letter by Darwin to his mentor, John Stevens Henslow, offers an example: "I fear the geology will take me a great deal of time, I was looking over one set of notes, & the quantity I found I had to read, for that one place was frightful" (DCOD, Letter 384, [4 November 1837]).

Books were integral to Darwin's information seeking, communicating, and use activities. In addition to being a means for solitary study and introspection, books also served as a focal point for discussion with scientific peers, which Darwin craved. In a letter to Charles Lyell, he expresses this yearning for the intellectual communion that books administered:

> Very many thanks for the present of your [just-published 1838 book] elements, which I received…I must talk to you about it. There is no pleasure in reading a book if one cannot have a good talk over it. (DCOD, Letter 424, CD to Charles Lyell, 9 August [1838]).

Reading current journal articles was also an important source of information and interaction for Darwin, as this 1838 letter from Darwin to geologist Charles Lyell demonstrates:

> By the way have you read the article in the Edinburgh Review on M. Comte Cours de la Philosophie, (or some such title)—it is capital—there are some fine sentences, about the very essence of science being prediction,--which reminded me of "its law being progress". (DCOD, Letter 428, CD to Charles Lyell, [14] September [1838]).

Throughout his life, books had a profound impact upon Darwin's life, as this 1845 letter from Darwin to botanist Joseph Dalton Hooker shows:

> If you see [Alexander von Humboldt, a Prussian naturalist] again, pray give him my most respectful & kind compliments, & say that I never forget that my whole course of life is due to having read & reread as a Youth his Personal Narrative. (DCOD, Letter 826, [10 February 1845]).

Barlow's (1958) Autobiography of Charles Darwin expounds:

> During my last year at Cambridge I read with care and profound interest Humboldt's *Personal Narrative*. This work and Sir

> J. Herschel's *Introduction to the Study of Natural Philosophy* stirred up in me a burning zeal to add even the most humble contribution to the noble structure of Natural Science. No one or a dozen other books influenced me nearly so much as these two. (pp. 67-68)..

21. Referencing: using a source of information to ascertain additional information.

Print materials used for referencing were a key component of Darwin's information behaviors. Onboard the *Beagle*, Darwin frequently consulted materials making up the ship's library, which was housed in the small cabin he shared. Browne (1995) recounts an incident indicating both the information seeking, use, and value of the *Beagle*'s reference materials, in which Darwin was endeavoring to identify some South American flatworms: "Careful work at his microscope and an exhaustive search through his reference books nevertheless persuaded him that these and another kind found at the seashore were entirely new to science" (p. 215). At times, Darwin bemoaned his lack of access to desired print reference sources. Hence, on a number of occasions, reference books were sent to Darwin by his brother, Erasmus, for pick-up in the *Beagle*'s ports of call. It was for the purpose of identifying these flatworms, in fact, that generated Darwin's need for the reference book, Cuvier's *Anatomie des Mollusques*, mentioned earlier in the rationale section of this dissertation. Browne (1995) explains that, "[John Stevens Henslow, Darwin's mentor] told Darwin he would send, via Erasmus, a copy of Cuvier's *Anatomie des Mollusques* which had all these species accurately described" (p. 215). Footnote 4 of Letter 1311 also offers another instance of Darwin's use of reference materials, stating that, "During the *Beagle* voyage CD used Patrick Syme's edition of *Werner's*

Nomenclature of Colours to identify the colours of specimens at the time they were taken" (DCOD, Letter 1311, Footnote 4, [26 January-March 1850]).

Browne (1995) also provides a lengthy but highly informative passage that not only illuminates the reference materials on the *Beagle* and their use by Darwin, but incorporates the access and use of those reference materials into a larger snapshot of Darwin's entire information process and his broad context information behaviors of seeking, organizing, managing, communicating, and use, even while far from England *and* on a shore excursion in South America:

> None of [Darwin's] collecting work was carried out in an intellectual vacuum. He brought with him a selection of authoritative natural history books from the *Beagle's* shelves. These included an important new encyclopedia of the living world edited by the French naturalist Bory de Saint-Vincent and other French scholars, the *Dictionnaire classique d'histoire naturelle* (1822-31), which ran to seventeen volumes and was full of articles by different experts giving the most advanced views of the day on their subjects. (p. 215-216).

Browne (1995) proceeds to list some additional marine life reference materials that Darwin utilized, such as "Lamarck's *Histoire naturelle des animaux vertebres* (1815-22), seven volumes on the identification, classification, and functions of mollusks and other invertebrates" (p. 216). She then discusses an example involving a number of Darwin's information behaviors, which invokes the sense of a kind of "distance information" process engaged in by him:

> If Darwin found his specimens or something comparable listed in the catalogues available to him, he usually made a dissection and provisional identification, acquiring in the process a fair idea of the scientific interest of each new set of organisms. Letters to Henslow filled any gaps; and Erasmus excelled in locating and

> sending the books his brother asked for. Darwin furthermore read as widely as he could among explorers' tales…He was, in fact, no more divorced from mainline scientific ideas than he was from ordinary English society. (Browne, 1995, p. 216).

Once back in England, Darwin often sought and gained access to reference materials situated in libraries throughout London, such as subscription libraries and those in private clubs, like the upper-crust Athenaeum's. This 1846 letter from Darwin to John Lindley, a botanist and horticulturalist, who was also an Assistant in Joseph Banks's library and herbarium in 1818 or 1819, provides an example:

> I have not forgotten your extremely kind offer of allowing me to consult Books in the Hort. Library; I have lately been busy with my geology & shall be for some time employed on Invertebrate zoology, but hereafter your kind offer will be of the greatest service to me. (DCOD, Letter 999, [c. 10 October 1846]).

Footnote 5 notes that, "Lindley was vice-secretary of the Horticultural Society and effectively ran it between 1841 and 1858" (DCOD, Letter 999, Footnote 5, [c. 10 October 1846]).

Though the term 'referencing' most often brings to mind print reference sources, referencing as an information behavior is applicable with regard to using non-print reference sources in the pursuit of information. This is evident in the next example, in which Darwin talks about having taken some birds collected in Madeira to the British Museum in order to compare them with British "reference birds" kept there. This 1856 letter is written by Darwin to Edward William Vernon Harcourt , a politician who had studied the natural history of Madeira:

> I took some of the little finches from Madeira to Brit Mus. & found the Goldfinch, Linnet & greenfinch rather smaller than the British specimens; but not the Blackbird,—nor, as you saw the Swift.— I

> wish I had taken more for comparison. (DCOD, Letter 1451, 19 Aug [1856]).”

22. Literature reviewing: skimming, reading, and referencing of print sources, narrowly focused on a specific topic or field, for the purpose of surveying the breadth and depth of known information on that topic or field.

Reading and analyzing a selection of Darwin’s letters in this dissertation, revealed several instances of another kind of reading engaged in by Darwin: a descriptive information behavior termed ‘literature reviewing’ for this study. As for any research study, reviewing the literature relevant to the topic proposed for investigation is a necessity. One purpose for this is to ascertain the extent to which a topic has previously been studied or how novel it is. An 1856 letter from Darwin to James Dwight Dana shows an area which Darwin determines has not been greatly studied:

> I have of late been chiefly at work on domestic animals, & have now got a considerable collection of skeletons: I am surprised how little this subject has been attended to: I find very grave differences in the skeletons for instance of domestic rabbits, which I think have all certainly descended from one parent wild stock. (DCOD, Letter 1964, 29 September [1856]).

Another purpose for conducting a literature review is to discover a chain of research or patterns in findings pertaining to a particular topic. Another identified instance from the 1856 letter cited above illustrates Darwin’s discussion about his use of ‘old literature’ to illuminate this kind of chain: “In the case of Pigeons, we have (& in no other case) we have much old literature & the changes in the varieties can be traced” (DCOD, Letter 1964, 29 September

[1856]). A few days later, in a letter by Darwin to William Darwin Fox, Darwin sheds further light on the value of "copious old literature" to his topic of inquiry:

> I have found my careful work at Pigeons really invaluable, as enlightening me on many points on variation under domestication. The copious old literature, by which I can trace the gradual changes in the Breeds of Pigeons has been extraordinarily useful to me. (DCOD, Letter 1967, 3 October [1856]).

Browne (1995) implicates the importance of Darwin's various reading behaviors, such as literature reviewing, stating that, "Darwin's theory ultimately rested on the prolific literature of the British Empire as much as it did on his inward soul-searching" (pp. 365-366). She asserts that Darwin "relentlessly exploited the huge surge in publishing activity during this period" and "made full use" of a broad spectrum of print materials that were produced by government and business publishers (p. 365).

23. Marking/Scoring: writing or affixing alphabetic characters, symbols, lines, notches, colors, etc. onto information or items, as part of an organization schema or to denote that some kind of action has occurred or needs to be performed.

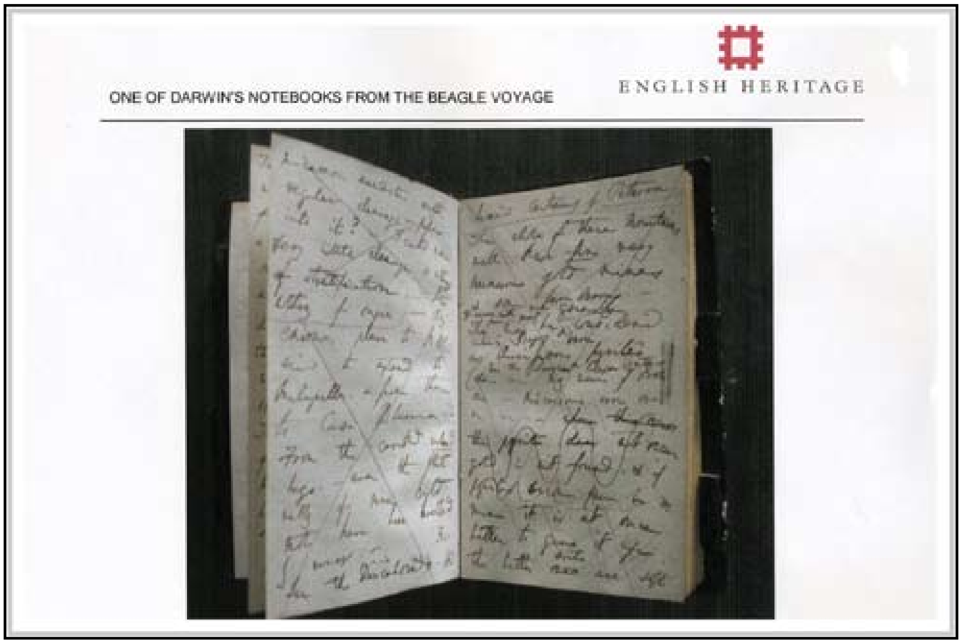

Figure 15. Inside of one of Darwin's *Beagle* notebooks, showing marking and scoring. Photograph provided for reprint by The Home of Charles Darwin, Down House, English Heritage.

Darwin employed a number of marking and scoring techniques involving different colors, in order to indicate to himself that certain actions had been performed. For example, he scored his notes to denote that he had revisited them and incorporated them into his writings. Scoring could also signify that the notes were no longer needed. Footnote 7 in a letter from William Freeman Daniell [a British surgeon and botanist] to Darwin describes Darwin's method: "This abstract is preserved with the letter in DAR 205.2 (Letters). CD marked it '18' in brown crayon, the number of his portfolio of notes on the means of dispersal of plants and animals" (DCOD, Letter 1970, 8 October – 7 November 1856).

The verso of Charles Darwin's notebooks, 1836-1844 (1987) provides two informative illustrations from Darwin's B and D notebooks, which further explain his marking and scoring methods. The text accompanying these illustrations explains how different colors were used at different times to indicate Darwin's actions:

> B126e was originally written c. September 1837, while the note in the bottom corner…was added in grey ink between 29 July and 20 October 1838. The additions [in brown crayon] were made in December 1856, when pages were excised and distributed to topical portfolios: 11 was the divergence portfolio [the number 11 can be seen on the page illustrating Notebook page B126e]…D134e was written in September 1838, when grey ink was Darwin's standard writing medium. The page was crossed in pencil, presumably after the note was of no further use. (Verso).

24. Labeling: writing on or attaching material with words, names, symbols, or colors to information and items; typically for identification, organization, or convenience.

Another predominantly information organizing-type behavior manifested by Darwin was labeling. He generally was conscientious about labeling and numbering the specimens that he collected in the field, as instances cited earlier in this dissertation have noted. A number of Darwin letters reference his labeling practices, such as one from Darwin to James David Forbes, an Edinburgh University professor of natural philosophy. In that letter, Darwin describes the rock specimens he is loaning to Forbes, telling him that, "All the specimens are labelled.— You can return them, whenever you like" (DCOD, Letter 790, 13 [November 1844]).

However, just as it is informative to identify information behavior examples showing Darwin's competency or great skill, examples highlighting lesser skill, and even errors, are illustrative.

The latter are particularly necessary to identify and discuss too, in order for this dissertation to provide a view of Darwin that addresses his strengths *and* his weaknesses, instances of his errors as well as his accuracy . As an area for potential future research, it is worth noting that examples showing Darwin's novice skills may also be useful in longitudinally tracking developmental changes, or lack thereof, in certain information behaviors over the course of his lifetime.

Quammen (2006) and Desmond and Moore (1991) discuss an instructional example that depicts Darwin's mislabeling of what would eventually be seen as perhaps his most iconic, as well as his most influential, *Beagle* specimens: the famed Galapagos finches. While in the Galapagos during the *Beagle* voyage, Darwin had collected a number of finches from the different islands. But he had failed to label which finches came from which islands (Quammen, 2006, p. 24). Desmond and Moore (1991) write that, "he had tagged his specimens in a desultory manner and had rarely bothered to label by island. It had not seemed important" (p. 172). "The lack of labeling had been, in retrospect a frustrating mistake", Quammen observes (p. 24). Quammen adds, in Darwin's defense, that "he hadn't known just what he was looking for" because he was not yet wedded to a specific scientific objective or theory (p. 24). Happily, as Darwin would appreciate later, he had also collected mockingbirds from different Galapagos Islands and had labeled the islands from which each specimen came.

Flashing forward to 1837, John Gould, a noted ornithologist with the Zoological Society of London, was endeavoring to catalogue and describe Darwin's avian *Beagle* specimens, including the Galapagos finches and mockingbirds. Though Darwin had written in his ornithological notes that the finches had come from different islands, his lack of labels for the finches could not evidentially support the assertion (Quammen, 2006, p. 25). "Continuing to collaborate with Gould, Darwin became more embarrassed by his lack of proper labels" (Desmond & Moore, 1991, p. 227). Darwin tried "to prove that each finch had its island home", going so far as looking at specimens collected by other *Beagle* crewmembers, including his assistant/servant, Syms Covington, who had gathered three Galapagos finches and correctly recorded each finch's respective island home (pp. 227-228). "Unlike the finches", Quammen relates, "the mockingbirds had reached Gould with island-of-origin tags…Darwin had been more meticulous as he collected them" (p. 24). Gould told Darwin that, "Each species [of mockingbirds], according to your labels, inhabits a different island" (p. 25). Darwin's attempts to reconstruct which finches came from which island were not as cut-and-dried. Desmond and Moore explain that Darwin's inquiries to the *Beagle* members vis-à-vis their Galapagos specimens "helped him to rack his memory and reconstruct his own finches' localities, although the by-guess-or-by-God approach led to errors" (p. 228). Ultimately though, Darwin came to the conclusion "that the finches, like the mockingbirds and tortoises, were island-specific" (p. 228). Insights like these were catalysts for his ideas and subsequent research of "transmutation", leading years hence to his eventual evolutionary theory by natural selection.

25. Numbering: assigning a number to information and objects; typically to indicate a position in a series and related to the arranging, listing, classifying, etc. of items and information.

Darwin used the descriptive information behavior of numbering to organize and manage his facts and information. While conducting research for this dissertation at Cambridge in

March 2006, intriguing information about Darwin's numbering was found in one of the Darwin Archive's finding aids pertaining to Darwin's pamphlet collection. The finding aid cites the late Darwin scholar Peter Vorzimmer's (1964) Ph.D. thesis's 2nd volume:

> At some time about 1850 Charles Darwin began to arrange the several articles, paper and reprints he had received into a numbered collection. He maintained this reprint collection until his death, when it was taken over by his son, Francis. (A catalogue of the Darwin Reprint Collection at the Botany School Library, Cambridge, compiled by Peter J. Vorzimmer, St. Catherine's College, Cambridge, 1963).

Footnote 1 of the finding aid cited above states that the 1850 date was "adduced from the fact that it is only from about that date that the collection takes on a distinctly chronological order." Darwin's numbering of some of his letters has facilitated Darwin scholars in dating his undated letters, as letter 1817's footnote 1 demonstrates: "CD's numbering of Blyth's letters (see CD's annotations and n. 67, below) also indicate the letter was written in 1856" (DCOD, Letter 1817, 8 January [1856]).

Armstrong (1985) notes that Darwin advised others to use numbering as well, thereby demonstrating the significance that he attached to it (p. 10). "Some years after the *Beagle* returned, he was asked to contribute to a scientific manual for those going on comparable expeditions, and he wrote: Every single specimen ought to be numbered with a printed number" (p. 10). Additional instances of Darwin's numbering behaviors will be discussed in conjunction with his listing behaviors below.

26. Listing: writing connected items, names, tasks, or information, which are frequently organized by category or numbered in order of priority or quantity.

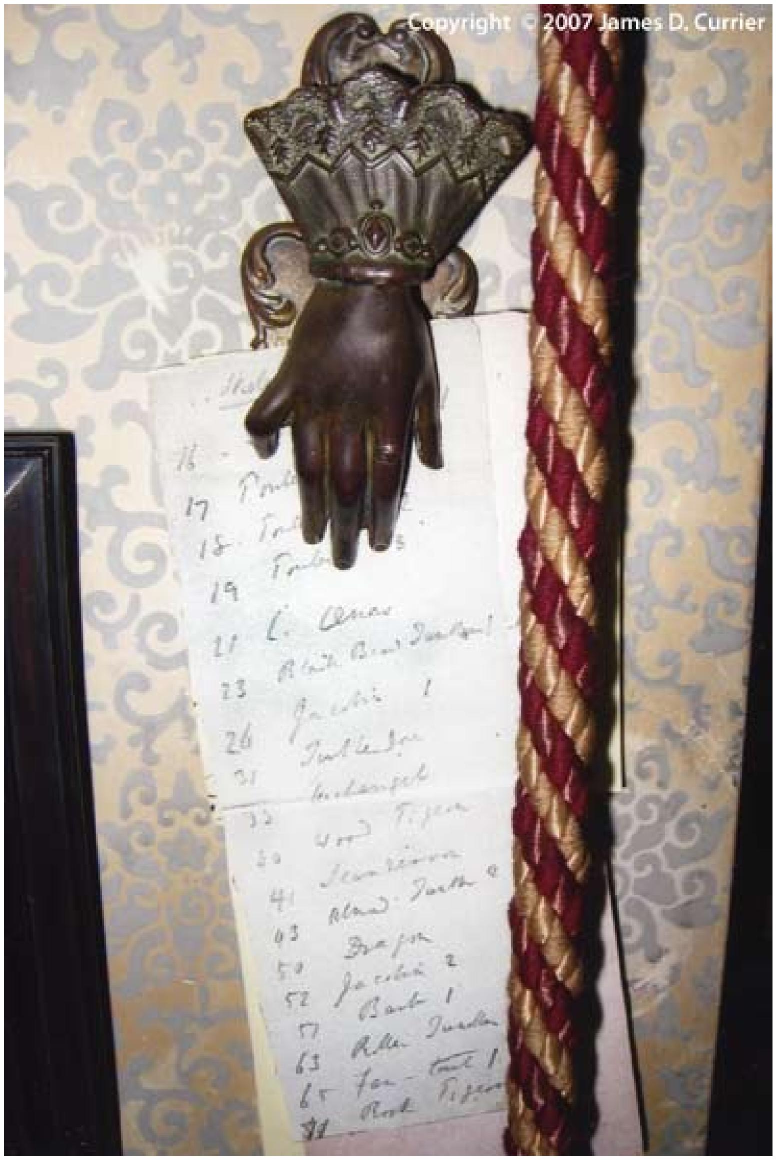

Figure 16. One of Darwin's lists, clipped beside fireplace in Down House study. Photograph taken by permission of The Home of Charles Darwin, Down House, English Heritage.

Lists were another manifestation of Darwin's information behaviors. "Darwin was an inveterate lister and scribbler throughout his life—his twenty books being the mere tip of the iceberg of his hand-written jottings" (Eldredge, 2005, p. 79). Perhaps the most fanciful of his lists is one in which Darwin listed his reasons for and against marriage (p. 79). These reasons are provided in CCD, Vol. 2, 1837-1843, Appendix IV: Darwin's notes on marriage, p. 443. Reasons "to marry" range from the romantic "only picture to yourself a nice soft wife on a sofa with good fire and books and music perhaps", to the practical "Constant companion (and friend in old age) who will feel interested in one", to the dispassionately reconciled "better than a dog anyhow" (p. 444). Reasons to "not marry" emphasize Darwin's bibliophilia and the value of face-to-face networking: "less money for books", "cannot read in the Evenings", and "Conversation of clever men at clubs" (p. 444). Darwin's eventual conclusion appears at the bottom of the list: "Marry—Marry—Marry" (p. 444). Ever the analytical questioner, though, below the treble 'Marry's, he asks a new query:

> "It being proved necessary to Marry
>
> When? Soon or Late" (p. 444).

As a married couple, Charles and Emma also were prone to list-making. "Typically, everything was listed and accounted for in the house, from fat dripping…3 [pounds], to the village Friendly Society. Their clockwork lives ran by calculations" (Desmond & Moore, 1991, p. 619). Darwin kept a "health diary" too, which listed and recorded his symptoms, as well as a weight book listing the weight of family members and visiting relatives.

Another habitual activity of Darwin's was his keeping of reading lists. These reading lists contained his notes about books that he intended to read and those he had read. Appendix

IV, entitled Darwin's reading notebooks, is located in Volume 4, 1847-1850, of the CCD; it explains the characteristics of reading lists composed by Darwin:

> In April 1838, Darwin began recording the titles of books he had read and the books he wished to read in Notebook C…In 1839, these lists were copied and continued in separate notebooks… Both notebooks consist of two different sections, headed 'Books Read' and 'Books to be Read'. (CCD, Vol. 4, 1847-1850, p. 434).

These lists served a number of functions. The appendix explains that:

> In the 'Books to be Read' entries, Darwin frequently included information that would help him locate the work, such as the publisher or series in which it was included, and often he listed the libraries which he thought might hold the book. (p. 434).

The reading lists sometimes provided the name of the person who recommended a particular print source or a notation by Darwin that an abstract of a source had been produced (p. 434). He also noted other actions that had occurred, such as recording whether he had read or skimmed various journals (p. 435). Darwin also listed scientific and non-scientific books separately. "Soon after beginning his first reading notebook, Darwin began to separate the scientific from the non-scientific books, with the scientific works listed on the left-hand pages…and the non-scientific on the right notebook" (p. 435). A couple of examples from Darwin's "Books to be Read, 1838-1851" lists are, "McNeil has written good article on Horticulture in Edin. Encylop. [Neill 1808] [Footnote 16 says that Emma Darwin made a mistake in copying the author's name]" (p. 439) and "Index of Clarkes Travels [Clarke 1810-23].—one volume I tried unreadable" (p. 442). Another comes from Darwin's peer, Joseph

Dalton Hooker: "Lindley's Vegetable Kingdom [Lindley 1846]. Hooker says very good for my purpose" (p. 451).

Three successive examples from his "Books Read 1852-60" list are comparatively informative:

- [July] 25 Lorenzo Benoni life of an Italian [Benoni 1853] (poorish)
- August 9th Haydon's Autobiography [Haydon 1853] (very interesting)
- [August] 25 Sir James Brooks Private Letters [Brooke 1853] moderate (p. 491).

Lists of specimens were also important to Darwin's work. The following example of an 1837 letter by Darwin to his mentor, John Stevens Henslow, is also noteworthy for its classifying aspects as well:

> I left with Miller, last winter some geological specimens.— I should be very much obliged if he would make **soon** a list of the numbers (*specifying the colour of the paper*) for otherwise I might be hunting in vain for hours. I ought at the time to have made a list, but neglected doing so. Footnote 1 of this letter states that, "CD's 'Diary of observations on the geology of the places visited during the voyage' (DAR 32.1, 32.2, and 33) has the number for each specimen in the margin; CD used paper of different colours for different ranges of numbers. In his notebooks listing geological specimens CD wrote the following code: Red = 1000 + &c Green = 2000 + &c Yellow = 3000 + &c Thus 378 yellow = 3378. The specimens are now in the Mineralogical Collection of the Department of Earth Sciences, Cambridge University. The notebooks are in the Darwin Archive, University Library, Cambridge, on deposit from the Department of Earth Sciences. Other lists of numbered specimens are in DAR 39.1. (DCOD, Letter 384, [4 November 1837])..

27. Indexing: making an alphabetical listing of information, names, subjects, etc., with references to the places where they occur; typically found at the end of a book.

Several instances identified in this study evince Darwin's indexing behaviors. Sometimes Darwin composed his own indexes and other times his letters talk about his delegating that task to paid others. One example of his indexing behaviors, which also serves to broadly reinforce Darwin's tendency for organizing, is found in his Questions & Experiments notebook. Given that this 158 x 198 mm account book (Barrett et al., 1987, p. 487) only comprised 40 pages, it is striking, and indicative of Darwin's desire for organization, that Darwin created an index for the notebook. As Barrett et al. describe, "The inside front cover of the notebook holds Darwin's index to the notebook; the names listed there comprise a diverse but impressive company of contemporary British figures in natural history" (p. 488). The index lists the names of persons on the left-hand side with a corresponding page number on the right-hand side. Hence, as examples, the listing 'J. Gray' has a page number across from it of '17', 'Horticulturalists' have page numbers of 'p. 21-23', with a an editorial transcription note that 23 written is in pencil, and so on.

Another indexing example, though it cannot directly be attributed to Charles Darwin himself, at the very least indicates the organizing tendencies of the Darwin family at Down House, in general. While examining several of Darwin's notebooks and original letters during the performance of research at Cambridge's Darwin Archives in March 2006, brief inspection was made of "Mrs. Charles Darwin's Recipe Book Down", so titled on the outer cover, and penciled on the insider cover "Emma Darwin May 16th 1839". This perusal revealed an intriguing alphabetical index, beginning on page 15 with "A" and "Apple Jelley [sic]", "34" and ending several pages later with "T" for a "Turnips [illegible]" dish on page "37".

28. Cataloging: making a systematic arrangement of items or information.

Darwin habitually catalogued his specimens or enlisted other to do cataloguing for him. Such catalogues frequently served as a reference source for him. A letter from Darwin to William Tegetmeier, who was a pigeon fancier and poultry expert, provides an example of this kind of information-related behavior: "Many thanks for your offers about dead Pigeons.— I return home tomorrow & will then look over my Catalogue & gratefully tell you what I want" (DCOD, Letter 1955, [18 September 1856]). Footnote 2 states that, "CD's Catalogue of Down Specimens (Down House MS) lists his specimens of experimental animals, including the pigeons" (DCOD, Letter 1955, Footnote 2, [18 September 1856]).

29. Classifying: assigning items and information to a particular class or category.

Darwin not only used classifying in his own work but also thought a great deal about its underlying principles and differing, often competing, classification systems. Classification was still in its early stages of development during the Victorian era and a uniform usage of classification had not yet been adopted by the global scientific community. An 1843 letter to George Robert Waterhouse, a naturalist who had described the *Beagle* voyage's mammalian and entomological specimens, shows Darwin's strong views about a proposed quinary classification system, as well as classification in general. Footnote 5 of this letter states that, “Waterhouse had adopted the procedure, popular among followers of William Sharp MacLeay’s quinary system, of representing closely related groups by contiguously placed circles; however, he did not accept all of MacLeay’s interpretations for these circles” (DCOD, Letter 718, Footnote 5, [3 or 17 December 1843]. Darwin wrote to Waterhouse that:

> I have one criticism to make about your circles—that is that I think you are bound to state that they do not necessarily represent (without you think they do) groups of equal value & though all touching, the affinities are not necessarily equally strong.— I believe infinite harm has been done by these circles, which catch the eye as of equal size, & inevitably lead the mind to suppose they are of equal value— it is by this artifice, as I believe, the possibility of making the Quinarian system appear probible has chiefly rested: Moreover it sh d be stated by everyone, I think, who indulges in these vicious circles, that confessedly there is no standard to judge of the value of groups.— Who can prove that the woodpecker are not a group of equal value with the Hawks.— I suspect that number of species, ie amount of variation of one common type does silently come into play in estimating the value of groups. (DCOD, Letter 718, [3 or 17 December 1843]).

An 1849 letter by Darwin to Hugh Edwin Strickland, who was a geologist and zoologist and an advocate for reform in zoological nomenclature, offers some interesting insight into Darwin’s feelings about classification rules:

> Do you happen to have a spare copy of the Nomenclature rules published in Brit. Assoc. Trans; if you have & w^{d}. give it me, I sh^{d} be truly obliged, for I grudge buying volume for it.— I have found the rules very useful; it is quite a comfort to have something to rest on in the turbulent ocean of nomenclature, (& am accordingly grateful to you) though I find it very difficult to obey always. (DCOD, Letter 1215, 29 January [1849]).

Footnote 3 explains that, "Both Strickland and CD had served on a British Association committee on zoological nomenclature (see *Correspondence* vol. 2) that had drawn up the rules published in *Report of the 12th meeting of the British Association for the Advancement of Science held at Manchester in 1842*" (DCOD, Letter 1215, Footnote 3, 29 January [1849]).

From 1846 to 1854, Darwin also devoted a great deal of time and effort to working on the classification of barnacles or *cirripedes*. The DCOD's Introductions to Volume 4 explain that Darwin's "interest in a singular species found during the *Beagle* voyage developed into an investigation of the comparative anatomy of other cirripedes and then into what became an authoritative and comprehensive taxonomical study of the entire group" (DCOD, Vol. 4, 1847-1850, Introduction, p. 1). Out of his work on barnacles, Darwin published two monographs, "describing all the known forms of that neglected and hitherto confusing sub-class of Crustacea" (DCOD, Vol. 4, 1847-1850, Introduction, p. 1). The DCOD explains that Darwin's "systematic descriptive work" and "species theory" helped to guide him "through a difficult, often frustrating taxonomical maze" during this significant period of work on barnacle classification (DCOD, Vol. 4, 1847-1850, Introduction, p. 1). In addition, Darwin's classifying behaviors are important because, "The success of his taxonomic work also illustrates Darwin's skill in ordering information" (CCD, Vol. 4, 1847-1850, p. 13).

30. Evaluating/Relevance-determining: assessing the value, usefulness, or applicability of information and things.

Evaluating the value and relevance of facts and information was vital to Darwin's information process.

Letter 2558, CD to Thomas Henry Huxley, 27 November [1859]: "About Breeding I know of no one Book.— I did not think well of Lowe, but I can name none better. Youatt I look at as far better *& more practical* authority; but then his views & facts are scattered through 3 or 4 thick volumes. I have picked up most by reading really numberless special treatises *& all* Agricultural & Horticultural Journals; but it is work of long years. **The difficulty is to know what to trust.** No one or two statements are worth a farthing,—the facts are so complicated. I hope & think I have been really cautious in what I state on this subject, though all that I have given, as yet, is **far** too briefly." Footnote 4 of this letter states that, "Low 1845. CD had read this work in 1846 (*Correspondence* vol. 4, Appendix IV, 119: 16a)" (DCOD, Letter 2558, 27 November [1859]). Footnote 5 of this letter writes that, "CD cited William Youatt's volumes on *Cattle* (1834), *The dog* (1845), and *Sheep* (1837) in *Natural selection*. See also *Correspondence* vol. 4, Appendix IV, 119: 7a and 11a" (DCOD, Letter 2558, 27 November [1859]). Footnote 6 indicates that, "For CD's reading of these and related journals, see *Correspondence* vol. 4, Appendix IV" (DCOD, Letter 2558, 27 November [1859]).

31. Recommending/Referring: to advise or approvingly suggest information, items, a procedure, or a venue as being suitable for a particular purpose.

A significant number of instances were found in which Darwin recommended information to people with whom he corresponded or referred them to sources or venues where they might locate information. He writes in an 1856 letter to John Phillips, a geologist and Assistant Secretary with the British Association for the Advancement of Science during the time when this letter was sent, that:

> I have been looking over my Chapter on Cleavage & Foliation in my Geolog. Observ. on S. America 1846, & with that candour so characteristic of authors I really think it worth your looking over.— Some remarks in first part of Chapt. p. 140, are, perhaps, worth skimming over; but the concluding remarks p. 162 give my results. (DCOD, Letter 1822, 18 January [1856]).

In the following excerpt, Darwin recommends the London Library to William Erasmus Darwin his eldest son and a banker, on behalf of an acquaintance:

> Tell Miss Mayor that the London Library is not rich in scientific Books, but yet I believe is the best. If her friend writes to "The Librarian, London Library, St James Sq e " he or she will get all information. Nothing is easier than to become a member. It requires I think, some one to recommend; & everyone must know some one member. (DCOD, Letter 2497, [23 October-20 November 1859]).

Footnote 3 says that, "The London Library was founded in 1841 as a subscription library for the use of scholars (*EB*)" (DCOD, Letter 2497, [23 October-20 November 1859].

Footnote 2 of an 1860 letter by Darwin to zoologist Thomas Henry Huxley states that, "Huxley had apparently asked CD for his main sources on hybridisation and related issues to assist him in the preparation of his lecture to be given at the Royal Institution on 10 February 1860" (DCOD, Letter 2558, 27 November [1859]). Darwin gave the following recommendations and referrals:

> Gärtner grand— Kölreuter grand, but papers scattered through many volumes & very lengthy: I had to make abstract of whole.— Herbert volume on Amaryllidaceæ very good & two excellent paper in Hort. Journal.—For animals no resume to be trusted at all: facts have to be collected from all original sources. (DCOD, Letter 2558, 27 November [1859]).

32. Preserving: maintaining information or items in their original or existing state.

Preserving information, whether in the form of books, letters, etc., was a priority for Darwin, as identified in a number of instances. Indeed, one of Darwin's worst fears on the *Beagle* was that his specimens and recorded notes would be lost or damaged, as nearly occurred on one occasion due to the swamping of waves.

Darwin evinces a concern for materials' preservation in an 1849 letter to botanist and close friend, Joseph Dalton Hooker:

> I forgot to say that I will carefully preserve all your letters: none have been destroyed, but those portions which did not contain any facts which I wanted to refer to again have been spitted & the other parts put in my portfolios, but half-an-hour's work will get them all together & it shall be done on my return home. (DCOD, Letter 1239, 9 April 1849).

Footnote 3, however, states that, "There is no evidence indicating that Hooker's letters were divided and 'spitted', although not all the surviving letters are complete" (DCOD, Letter 1239, Footnote 3, 9 April 1849). In another letter to Hooker, referring to botanical books that Hooker has loaned to him, Darwin expresses his preservation instinct and intent: "I…will see that the Books are covered & are taken scrupulous care of" (DCOD, 2140, 11 September [1857]).

Darwin also was not shy about asking others to take care of his information, as this 1850 letter excerpt from Darwin to Albany Hancock, a zoologist and paleontologist, describes:

The notes are those of an *ignorant schoolboy* as I was almost then, & shamefully written; I wd have copied them out, if they had had any value.— Will you nevertheless please preserve these notes, for as one sometimes likes to see an old book, so I like to keep my wretched zoological notes. (DCOD, Letter 1311, [26 January-March 1850]).

Another aspect of Darwin's preserving behaviors was that regarding specimens. A letter by Darwin to Charles Spence Bate, a dentist and scientific writer who was an authority on crustacea, details Darwin's advice for preserving specimens:

> I think you will find it useful to preserve small objects, in a way in which I have been accustomed to preserve the results of most of my minute anatomical researches, namely in common water without any spirits, with a Bit of thin glass over the object (without any cell) & gold size all round the rough edge—objects thus prepared will sometimes keep for a long time & generally for some months. (DCOD, Letter 1340, 13 June [1851]).

Footnote 5 reports that, "CD's method for preserving specimens accords well with that recommended by John Thomas Quekett (Quekett 1852, pp. 283–4)…Many of CD's cirripede preparations in the collection given by Francis Darwin in 1870 to the Cambridge University Museum of Zoology are still well preserved after 140 years, although in some cases the cement has run in and spoiled the specimens" (DCOD, Letter 1340, Footnote 5, 13 June [1851])."

33. Copying: making a similar or identical version of information.

Copying was a laborious but necessary information-related behavior of Victorian era scientists. An 1833 letter from Darwin's Cambridge University mentor, John Stevens Henslow, sent to Darwin during his tenure on the *Beagle*, provides an excellent example of the strong rationale for copying:

> W<ould> it not be a good precautionary measure to transmit to England a copy of your memoranda, with your next packet? I know it is a dull job to copy out such matters—but it is highly expedient to avoid the chance of losing your notes by sending home a duplicate. (CCD, Vol. 1, 1821-1836, p. 294).

Darwin did some of his own copying throughout his life, but when possible he delegated his copying jobs to others, as detailed in the preceding discussion of delegating.

34. Extracting/Excising: removing, taking out, or deriving information or things, often a portion from a larger thing.

In the richly-detailed authoritative work *Charles Darwin's Marginalia* by Di Gregorio (1990), which was mentioned earlier in the Literature Review section, the editor, with assistance, transcribes and analyzes thousands of annotated comments and marginal notes that Darwin wrote in his books, notebooks, and other printed materials. A focus of the study was to identify Darwin's assessments of the writings by other authors and researchers. One of the key points identified in the project was that, "CD's principal 'layer of response' to a text, constituting the great bulk of the annotations, was in fact data collection, or 'extracting'" (p. xiii). The study found that, "the whole process was strongly purposive—namely, to assemble a vast store of sometimes tiny points of information in order to illustrate and support the Great Theory" (p. xiii). Hence, Darwin habitually extracted facts and information from myriad sources. Di Gregorio (1990) writes that, "CD often judged a book on the sole criterion of its relevance to some aspect of his Grand Enterprise" (p. xiii). Examples of CD's relevance determining annotations cited by Di Gregorio include "After p. 109 not one word for me", "I doubt whether any use" or the sign "O/", meaning "Nothing for me" (pp. xiii-xiv). This type of evaluating and relevance determining preceded the extraction of materials which he deemed potentially relevant or useful. Extracted information was frequently annotated and then filed, until it would be retrieved for reevaluation later and possible incorporation in a writing or work of Darwin's. An 1844 letter from Darwin to botanist Joseph Dalton Hooker has an explanatory footnote with an extracting example, that states, "CD had an extract copied from Macleay 1819–21 by Syms Covington (DAR 71: 128–38). In CD's notebooks there are several remarks which show that he had given the [quinarian classification] system his serious critical attention" (DCOD, Letter 745, Footnote 7, 5 April 1844).

In addition to extracting material of interest from print materials, which often occurred through copying but not necessarily the cutting or removing of that material, Darwin's excising behaviors resulted in the literal cutting out of portions of facts and information from their original sources. Examples abound of pages and notes, which Darwin excised from books, articles, and newspapers. Desmond and Moore (1991) note an1856 instance of Darwin's extracting and excising behaviors, in which "he cannibalized his twenty-year-old transmutation notebooks, sorting the pages into thirty or forty large portfolios, ready to be reworked" (p. 448).

An 1838 letter written to Darwin by his second cousin, William Darwin Fox, provides two examples of Darwin's excising behavior. In one section of the letter, where Fox's sentence "So much for my enquiries" appears, an editorial note reading <rest of page excised> appears to the right. The same editorial comment also appears again at the bottom of the letter, adjacent to Fox's words "Tell me whether". (DCOD, Letter 418, [*c*. November 1838]).

35. Incorporating/Inserting: uniting or merging information or objects with another existing entity.

After Darwin had collected, evaluated, and frequently annotated the information he had acquired, he then or at a later time decided how and where he would incorporate or insert that information. Footnote 1 in an 1858 letter from Darwin to Augustus Addison Gould, who was a Boston, Massachusetts physician and conchologist, explains that Darwin had written to Gould, seeking "information about cuckoos while he was composing chapter 10, on the 'Mental powers and the instincts of animals', which he completed on 9 March 1858" (DCOD, Letter 2448, Footnote 1, 6 April [1858]). Gould sent Darwin information that had been given to Gould by Thomas Mayo Brewer, who was a Boston publisher and ornithologist. The footnote then provides an illustrative example of Darwin's information incorporating behaviors, as well as his marking, filing, and retrieving behaviors:

> Brewer's letter was marked 'Ch. 10' by CD (see letter from T. M. Brewer to A. A. Gould, [March 1858]) and put with his other notes on instincts. CD incorporated Brewer's information into *Origin*, p. 217, when he came to write up this material in November 1858. (DCOD, Letter 2448, Footnote 1, 6 April [1858]).

36. Arranging: putting items and information in a neat, required, and/or useful order.

Figure 17. View inside Darwin's study at Down House. Photograph taken by permission of The Home of Charles Darwin, Down House, English Heritage.

Arranging his information and items in ways that facilitated their storage, retrieval, and accessibility, was important to Darwin. It gave him a considerable edge too, as will be demonstrated in the case study below. Darwin learned a lot about the need for arrangement as a result of his five years spent in the cramped confines of the *Beagle*. After Charles and Emma's move to Down House in 1842, Darwin arranged and customized his study, where most of his work was conducted over the remaining forty years of his life, for maximum efficiency. Browne (1995) describes:

> Darwin arranged his study to his liking, with special wooden shelves in an alcove by the fire serving as an impromptu filing

cabinet for all his different notes. He hung up pictures of Lyell, his father, and the two grandfathers, put all his books together according to their subject, and installed a mirror beside the window discreetly angled so that he could see who was coming up the drive. The room was his inner sanctum—a gentleman's retreat…a smaller version of his rooms in Christ's College, Cambridge, or of the book-clad library in the Athenaeum. (p. 445).

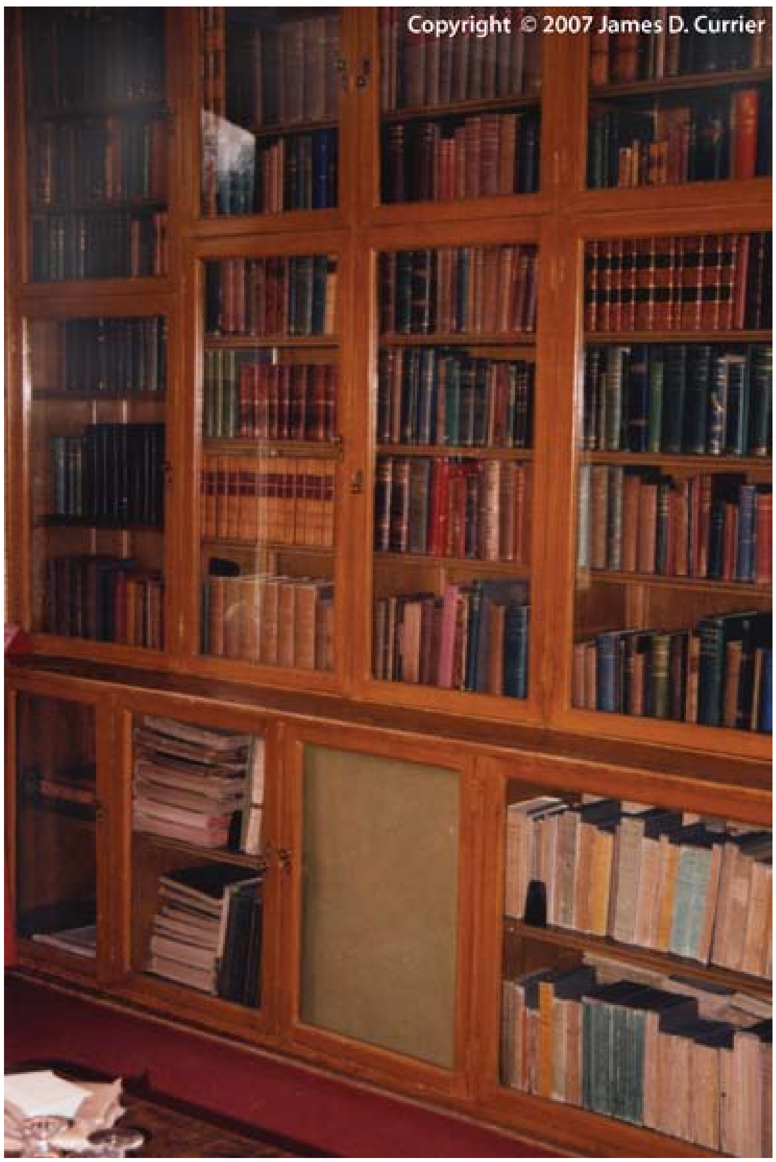

Figure 18. Bookshelves in Darwin's study at Down House. Photograph taken by permission of The Home of Charles Darwin, Down House, English Heritage.

37. Filing/Storing: placing information and items in a cabinet, box, folder, portfolio, etc., in a particular order, for purposes of preservation and easy reference.

Figure 19. 16-shelf magazine portfolio in Darwin's study at Down House. Photograph taken by permission of The Home of Charles Darwin, Down House, English Heritage.

As discussed in the arranging section above, Darwin's filing and storing behaviors were significantly influenced by his five years of living and working on the *Beagle* in a shared cabin, which also housed the ship's library. As Eldredge (2005) describes, "Darwin learned the importance of tidy organization while in his cramped quarters on the *Beagle*" (p. 81). Eldredge provides a photo of the corner of Darwin's study where his magazine portfolios were placed. In the caption he explains that, "The shelves above his desk…each contained notes for an individual topic or chapter of the *Origin of Species*, reflecting earlier organizational habits on the high seas" (p. 81).

An 1844 letter by Darwin to his wife Emma offers a revealing example as well as editorial background information regarding Darwin's filing and sorting behaviors. At this time Darwin was working on his transmutation ideas. The following letter, excerpted here, was prepared by Darwin in the event that he should die before his work was published. It instructed Emma in detail on how to proceed with such publication. The following passage pertains to some of his filed "scraps" of information:

> I also request that you hand over <to an Editor> all those scraps roughly divided in eight or ten brown paper Portfolios:— The scraps with copied quotations from various works are those which may aid my Editor. (DCOD, Letter 761, 5 July 1844).

Footnote 4 explains that, "After 1839, CD began the practice of filing his notes in separate classified portfolios. Many of the 'scraps' are still preserved together in various DAR volumes, e.g., DAR 46.1 has the notes assembled for writing 'Struggle for existence', chapter five of

Natural Selection, later chapter three of the *Origin* ; other loose notes are in DAR 205.1 to DAR 205.11" (DCOD, Letter 761, Footnote 4, 5 July 1844)..

Figure 20. Filing cabinet with papers in Darwin's study at Down House. Photograph taken by permission of The Home of Charles Darwin, Down House, English Heritage.

38. Retrieving: regaining possession of information and items, following prior acquisition and storage.

The ability to retrieve the trove of facts and information which Darwin collected and stored, gave him a crucial advantage, especially in terms of his ability to gather, organize, manage, and use that information in furtherance of his publication objectives. During dissertation research at Cambridge University Library in March 2006, a sampling of Darwin's original letters written in his own hand, and accessible with a Reader's Ticket for the library and the Darwin Archives, was examined. The following example written in 1877, just five years before Darwin's death in 1882, offers some insights into Darwin's sometimes unorthodox ability to retrieve his stored materials. It also underscores the legibility challenges, with regard to Darwin's unique and notoriously difficult to read handwriting, vis-à-vis fully deciphering Darwin letters, such as the example below, that are as-yet unedited, untranscribed, and unpublished. Words which this researcher was unable to interpret are bracketed as [illegible]. The letter, dated [10 June 1877], was written by Darwin to his son Francis (whom Darwin called Frank):

> My Dear Frank,
>
> Please look in my working corner in study and on upper shelf, you will find a bottle of…also please look in tin box on floor, beneath a pile of paper portfolios, for a portfolio on worms and in this [illegible] is a paper or bundle of papers by William on covering of earth within Beaulieu Abbey. (DCOD, Letter 10995, [10 June 1877]).

The example, though whimsically conjuring an image of clutter and disorder, actually reveals order within the ostensible disorder: Darwin *knows* where his earthworm notes are located, amidst the assorted piles and items housed in his study. Within this surface disorder, there is in fact a system of order and organization. In the same vein, a number of LIS studies have identified order and organization from the ways in which researchers sort information by piles in their offices and know within what piles different types of information are likely to be located. Additional examples of Darwin's retrieving behaviors will be discussed in the case study below, examining a period when the retrievability of Darwin's print documentation was vitally important to the priority of his theories.

39. Reflecting: thinking about information, often deeply, carefully, and at length.

It is interesting to note that in his autobiography (Barlow, 1958), Darwin articulated the information-related cognitive activity of sustained reflection as one of a handful of "complex and diversified mental qualities and conditions" that he perceived as important to his "success as a man of science" (pp. 144-145). Specifically, he described this characteristic as "unbounded patience in long reflecting over any subject" (p. 145). Darwin often reflected on his ideas and work while strolling along his shaded "sandwalk" at Down House. As with several other DIBs discussed in this dissertation below, identifying instances which demonstrate this type of reflecting behavior present more challenges than the majority of DIBs, such as collecting, recording, annotating, corresponding, etc., where tangible physical evidence can be fairly easily identified and cited. An example of Darwin's reflecting is provided, by means of an 1856 letter by Darwin to his geologist friend, Charles Lyell: "With respect to your suggestion of a sketch of my view; I hardly know what to think, but will reflect on it; but it goes against my prejudices" (DCOD, Letter 1866, 3 May [1856]).

40. Experimenting: performing a scientific procedure to determine something or to assess the meaning of information through the scientific method; also, trying out new concepts or ways of doing things.

Experimenting was a means by which Darwin sought but also used information. This excerpt from an 1858 letter by Darwin to his cousin, William Darwin Fox, illustrates the broad context information behaviors (BCIBs) of information seeking and information use, as well as his experimenting behaviors:

> I have lately been observing & experimentising with much care on the construction of Bees' cells & have been testing the accuracy of Huber's observation & on some points I do not think the blind man's observations stand the test very well. (DCOD, Letter 2296, CD to William Darwin Fox, 27 [June 1858]).

Darwin's experimenting behaviors were also touched upon in the indexing section above, during description of the index that he placed in his Questions and Experiments Notebook.

41. Compiling: assembling information collected from other sources.

Collating facts and information extracted from a variety of relevant sources and then compiling that information was an important part of Darwin's information behavior process. Darwin realized, though, that it wasn't enough to simply find, extract, and assemble the information: it also needed to be verified as accurate, in order to weed out erroneous facts and incorrect analyses. The following excerpt from an 1858 letter written by Darwin to Thomas Henry Huxley offers some insights into compiling in general, as well as Darwin's own information compilation process:

> The inaccuracy of the blessed gang (of which I am one) of compilers passes all bounds: *Monsters* have frequently been described as hybrids without a tittle of evidence.— I must give one other case to show how we jolly fellows work— A Belgian Baron (I forget name this moment) crossed two distinct geese & got *seven* hybrids, which he proved subsequently to be quite sterile; well compiler the first, Chevreuel, says that the hybrids were propagated for *seven* generations inter se. Compiler 2 d . (Morton) mistakes the French names, & gives Latin names for two more distinct geese, & says *Chevreul himself* propagated them inter se for seven generations; & this latter statement is copied from Book to Book! (DCOD, Letter 2224, 24 February[1858]).

42. Verifying/Confirming: making certain that information is true, accurate, or justified.

Darwin was extraordinarily conscientious about verifying and confirming the information that he compiled and incorporated in his works. An 1849 letter from Darwin to Charles Lyell provides an example of Darwin's checking of information for accuracy to determine whether its inclusion in a work might need to be revised:

> This letter requires no answer, & I write solely from exuberance of vanity. Dana has sent me the Geolog. of U.S. Expedition & I have just read the Coral Part.— [Dana 1849a, ch. 2]…To begin with a modest speech, *I am astonished at my own accuracy* !! if I were to rewrite now my coral book, there is hardly a sentence I sh d . have to alter—except that I ought to have attributed more effect to recent volcanic action in checking growth of coral. (DCOD, Letter 1275, 4 December [1849]).

Occasionally, Darwin also enlisted those knowledgeable in certain fields to look over and verify his information. In an 1856 letter Darwin solicited verification from a Cambridge contemporary named Thomas Campbell Eyton, who had opened a Shropshire museum in 1855, which housed a collection of skins and skeletons of European birds:

> I am getting on with my collection of Pigeon skeletons & have every breed alive. I have not yet compared carefully the skeletons; but when I do I shall probably have occasion to beg your assistance; for it would *greatly* add to value of any few remarks which I might make, if I could say that you had seen them & thought my remarks accurate. (DCOD, Letter 1942, 21 August [1856]).

43. Modifying/Adapting: making partial or minor changes to information or an object; typically in order to improve it or make it more useful.

Darwin modified and adapted nearly everything in his information environment to meet his individual needs and preferences, which was fitting for a man who wrote about adaptation's importance for living organisms. While visiting Down House in March 2006, the home's Curator, Ms. Tori Reeve, stressed this key theme of Darwin's life with numerous examples: Darwin's favorite black chair, in which he wrote and thought daily when at home, was modified with rolling wheels to promote easy movement. The study's tables, upon which sat specimens and sundry items, were outfitted with wheels too, so they could be easily moved around the study, as needed. On the floor in a curtained corner of the study, a privy sat on the floor, for times when the frequently ill Darwin needed to retch. Old wooden boxes were used as shelves, and shelves were utilized as filing cabinets for his notes (Browne, 1995, p. 445). Wall maps were adapted into vertical notebooks, as it were, with annotated notes and markings covering many of the Earth's cartographic seas and continents, for quick and easy visual reference.

Figure 21. Darwin's chair that he modified with rollers in Down House study. Photograph taken by permission of The Home of Charles Darwin, Down House, English Heritage.

To the likely horror of bibliophiles, Darwin also modified large or heavy books by tearing them up, carrying just the parts he needed, and thus, adapting larger containers of information into smaller, more portable, condensed formats. A final example of his modifying behavior is the mirror that was installed outside the study window, enabling Darwin to conveniently spot, without leaving his rolling black chair, anyone approaching from the driveway. Darwin's study, thus, was a modified microcosm of the ways in which he adapted information and objects to best suit his individual wants and needs, as well as to mitigate his fears and anxieties.

44. Revising/Altering: Reexamining, reconsidering, and making alterations to information or something, often due to additional information, new insights, or the need to correct errors.

"Obsessively detailed, cautious, and meticulous", Browne (1995) says, in discussing the precision with which Darwin maintained his account books, this tendency reveals "more of his character than even his eventual autobiography" (p. 405). This commitment to precision was equally evident in his work and writings. A letter by Darwin to his mentor, John Stevens Henslow, demonstrates his concern for accuracy in his writings:

> I am sorry to find, that a good many errata are left in the part of my volume, which is printed: During my absence Mr Colburn employed some goose to revise, & he has multiplied, instead of diminishing my oversights. (DCOD, Letter 384, [4 November 1837]).

When errors were found, Darwin took steps to revise and alter them, as Footnote 3 of this letter points out: "Before publication CD added an appendix to the first edition containing corrections and some new material. See *Journal and remarks*, Preface and Addenda" (DCOD, Letter 384, Footnote 3, [4 November 1837]).

In this next excerpt, written five months before *Origin*'s November 24, 1859 publication, Darwin's commitment to accuracy shines through as well. In a letter to his friend, Charles Lyell, whose *Principles of Geology* had so profoundly influenced Darwin while on the *Beagle* voyage, 21 June [1859], Darwin describes his revising and altering work—and its heavy toll upon him:

> I am working very hard [on the proofs of *Origin*], but get on slowly for I find that my corrections are terrifically heavy, & the work most difficult *to me* . I have corrected 130 pages; & the vol: will be about 500. I have tried my best to make it clear & striking; but very much fear that I have failed, so many discussions are, & must be, very perplexing.— I have done my best. If you had all my materials, I am sure you would have made a splendid Book. I long to finish, for I am nearly worn out. (DCOD, Letter 2470, 21 June [1859]).

Darwin's attention to detail and meticulousness threatened to sideline him from publishing the first edition of *Origin* in 1859, but Charles Lyell repeatedly coaxed his friend to get it published. His sense was that Darwin could later revise *Origin* and compose the longer book that he wanted to write, "which would give the sources and fuller evidence for his theory" (DCOD, Letter 2501, Footnote 4, 3 October 1859). Footnote 4 of this letter explains that Darwin "came to agree with Lyell" and he "remained content with making revisions and additions to successive editions of Origin" (DCOD, Letter 2501, Footnote 4, 3 October 1859). Hence, these examples highlight Darwin's revising and altering of his writings for the purposes of adding more information and new information, as well as for correcting mistakes or oversights.

45. Understanding: mentally interpreting and comprehending information, in a manner typically involving the use or application of that information.

As discussed in the previous section on reflecting, pinpointing the ways in which Darwin understood information is more difficult that identifying instances of, for example, his collecting, listing, and corresponding activities. Understanding information implies an internal process, whereas the examples given leave behind physical evidence of their existence. Hence, one must rely on Darwin's descriptions of his own behaviors indicating his understanding of information. An example that offers some glimpses into Darwin's understanding of information is found in an 1839 letter written by Darwin to William Whewell, who was a Cambridge University professor of moral philosophy:

> A short time since I finished, having only skimmed parts before, another & quite different production of yours,—the Hist of Inductive Sciences, [Whewell 1837]—& I will run the risk of appearing exceedingly presumptuous by telling you how much I enjoyed it—to see so clearly the steps by which all the great scientific discoveries have been come to is a capital lesson to every one, even to the humblest follower of science & I hope I have profited by it. (DCOD, Letter 506, 16 April [1839]).

46. Explaining: making information understandable by describing it or revealing relevant facts or ideas.

How to explain species mutability—to use information in a way that revealed its underlying purpose—was a central objective influencing Darwin's information behaviors. Scientific explanation was certainly the aim for his other work as well, whether pertaining to coral reefs and volcanic islands, species variety in animals and plants, etc. An 1857 letter from Darwin to botanist Joseph Dalton Hooker offers an instance that evinces Darwin's efforts to find information in order to use it to explain larger questions or processes. In this example Darwin communicates his intent to potentially use information about botanical varieties for purposes of explanation:

> I intend dividing the varieties into 2 classes as Asa Gray & Henslow gives the materials, & further A. Gray & H. C. Watson have marked for me the forms, which they consider real species,

> but yet are very close to others; & it will be curious to compare results. If it will all hold good it is very important for me; for it explains, as I think, all classification, ie the quasi-branching & sub-branching of forms, as if from one root, big genera increasing & splitting up &c &c, as you will perceive. But then comes, also, in what I call a principle of divergence, which I think I can explain. (DCOD, Letter 2134, 22 August [1857]).

Darwin also focused much effort on obtaining information about animal species, specifically, domesticated breeds and wild varieties. Browne (1995) discusses Darwin's explaining-related information behaviors:

> He had always thought it important to locate a symmetry between the normal world and animals and plants under domestication; and he usually evaluated the theories spelled out in his notebooks according to how well they explained information gathered from both the farming community and conventional natural history. (p. 389).

Another example of explaining comes from an 1844 letter by Darwin to Leonard Jenyns. Jenyns was a naturalist, clergyman, and the brother-in-law of Darwin's Cambridge mentor, John Stevens Henslow; he also described Darwin's fish specimens from the *Beagle* voyage. Telling Jenyns that he looks forward to seeing Jenyns's recently published work, Darwin writes that:

> [M]y work on the species question has impressed me very forcibly with the importance of all such works, as your intended one, containing what people are pleased generally to call trifling facts. These are the facts, which make one understand the working or œconomy of nature. (DCOD, Letter 782, 12 October [1844]).

This excerpt is significant because it unequivocally demonstrates the value Darwin attached to the facts and information that he assessed as beneficial to his research goals and objectives. He sees utility and the potential for explanation in information that others would dismiss as "trifling" or insignificant. A little bit further in this same letter, Darwin again describes how his information seeking is used to explain his most influential ideas:

> I have continued steadily reading & collecting facts on variation of domestic animals & plants & on the question of what are species; I have a grand body of facts & I think I can draw some sound conclusions. The general conclusion at which I have slowly been driven from a directly opposite conviction is that species are mutable & that allied species are co-descendants of common stocks. (DCOD, Letter 782, 12 October [1844]).

It is important to note that Darwin also saw the need to confront and address facts and information that were contrary to his ideas and views. He recognized that this challenging of another's views was a requisite and beneficial part of the scientific process. It was also a necessary part of the process of explaining facts and information, and from a larger standpoint, explaining scientific phenomena and theories, like his on evolution by natural selection. An 1856 letter from Darwin to zoologist Thomas Henry Huxley evinces Darwin's seeming awareness of his need to address facts that were in conflict with his own facts and potential explanations: "I require passages, but I always give all the facts which I can collect, *hostile* to my notions" (DCOD, Letter 2020, 13 [December 1856]).

47. Quoting: mentioning or referring to information in order to provide evidence or authority for a statement, argument, or opinion.

Quotes of facts and information were routinely cited and used by Darwin as evidence and authority in his works. The following letter from Darwin to his cousin, William Darwin Fox, who was a fount of information for him, offers some insights into Darwin's selection of facts and the quoting of them :

> Thanks, also, for fact about Terriers— Jesse has a very parallel fact about his own *Family* of Terriers, which grinned & protruded feet when ca-ressed.— I shall try & quote your fact, but, as I before said, I am over facted. (DCOD, Letter 2230, 28 February [1858]).

Footnote 5 notes that, "CD cited Fox on the inheritance of the behavioural traits of his Skye terrier in *Natural Selection*, pp. 480–1 n. 2. CD also referred to Jesse 1835, p. 149" (DCOD, Letter 2230, Footnote, 5, 28 February [1858]).

Another example of Darwin's quoting behaviors also comes from a letter to William Darwin Fox. This excerpt sheds light on Darwin's evaluating of the quality and relevance of facts and information that he quoted and used: "Your fact about Call-Ducks is *first-rate* for me, & I will quote it; as I particularly wanted such cases of influence of parent, independently of instinct" (DCOD, Letter 2296, 27 [June 1858]). Footnote 3 reports that, "CD had asked Fox to provide him with reliable information on the instincts of animals (letters to W. D. Fox, 14 January [1858] and 31 January [1858])" (DCOD, Letter 2296, Footnote 3, 27 [June 1858]). Footnote 5 also states that Darwin had asked Fox for some information on black lambs and that, "Fox is cited in *Variation* 2: 30 as CD's source of information on black lambs' sometimes being born to

Leicester sheep, a breed carefully bred for its white wool" (DCOD, Letter 2296, Footnote 5, 27 [June 1858]).

48. Publishing: to print information in a written format, typically for sale or free distribution.

The publication of Darwin's writings was another vital part of Darwin's information process. He understood that getting his ideas into a published format was important for disseminating his ideas and preserving the priority and originality of his ideas, which was a significant goal for Victorian era scientists. With the publication of *Origin of Species* on November 24, 1859, Darwin achieved an objective that had been more than twenty years in the making. *Origin* also represented the end product for Darwin of a lifetime and panoply of information behavior-directed activity. During the March 2006 research trip to Down House, an original autographed edition of *Origin* was observed and photographed, as included in this section. Additional instances of Darwin's publishing behaviors will be examined in the dispersing and propagating sections and the Darwin/Wallace case study below.

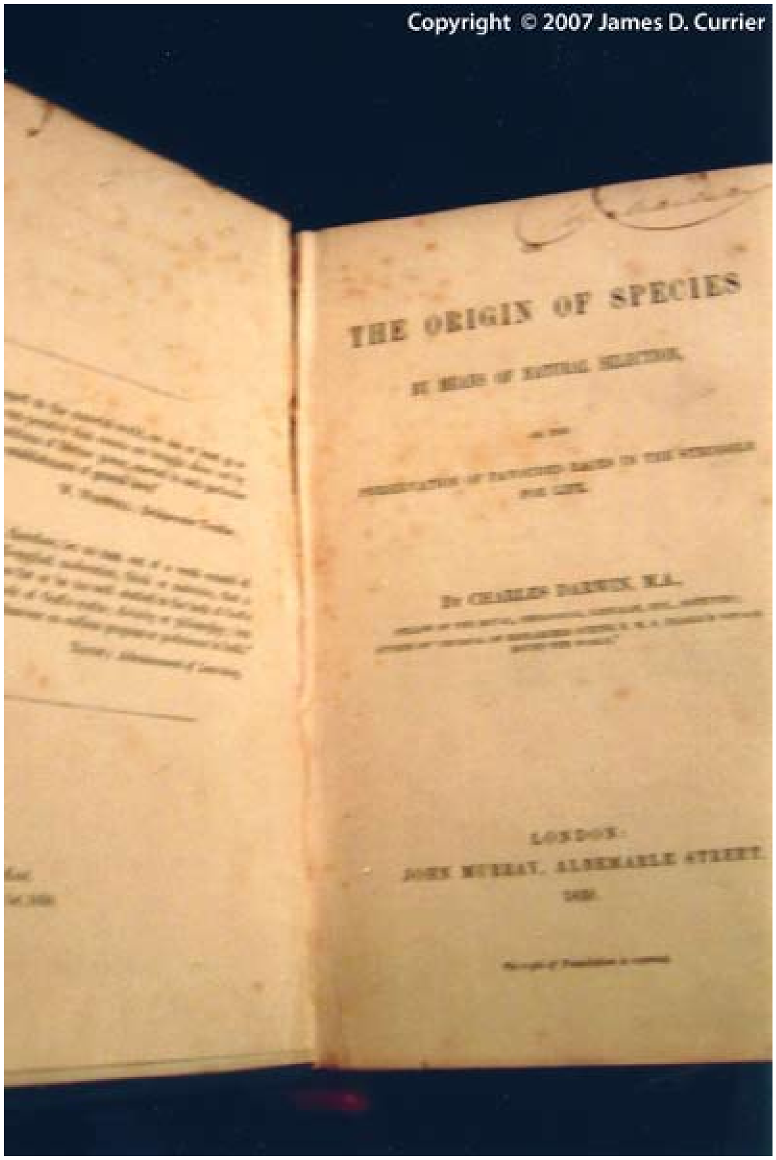

Figure 22. *Origin of Species*, autographed by author Charles Darwin. Photograph taken by permission of The Home of Charles Darwin, Down House, English Heritage.

49. Presenting: to deliver information orally; typically to a group or audience.

Darwin's presentation of his ideas and work to live groups diminished greatly following his move from London to Down House in 1842. Chronic illnesses were a key factor inhibiting his ability and inclination to travel, even to London, which was roughly twelve miles to the north. Prior to that though, and following his return from the *Beagle* voyage in 1836, Darwin occasionally presented his papers to professional societies in London. An 1837 letter from Darwin to his mentor, John Stevens Henslow, offers an example: "On Wednesday I am going to read a short account of my views of the whole affair" (DCOD, Letter 356, [28 May 1837]). Footnote 3 states that, "CD read his paper 'On certain areas of elevation and subsidence in the Pacific and Indian Oceans, as deduced from the study of coral formations' at the Geological Society on 31 May 1837" (DCOD, Letter 356, Footnote 3, [28 May 1837]). Occasionally peers, such as his friends Hooker and Lyell, presented or facilitated the presentation of Darwin's work on his behalf. A pivotal instance of such presentation occurred at the Linnean Society on July 1, 1858, in a canny stratagem intended to secure Darwin's priority for his evolutionary theory. This fateful 11th hour Linnean Society presentation of Darwin's ideas will be examined at greater length in the case study below.

50. Claim-staking: using information in order to assert one's ownership or priority in something.

Darwin sometimes communicated and used information as a means for staking his claim to that information or the theories of which that information was a part. Hence, this dissertation employs the derived term of claim-staking to describe such instances. At times Darwin coyly revealed parts of his theories to select correspondents but routinely held back from divulging all, except to his most trusted confidantes. He was suspicious, and even had a mirror installed outside his Down House study, in order to observe anyone approaching the house via the driveway. This excerpt from an 1856 letter that Darwin wrote to Charles James Fox Bunbury, a botanist who was also Charles Lyell's brother-in-law, depicts his claim-staking behavior:

> As you say you like scientific chat, & your kind letter makes me sure that you will not think me an egotistical bore, I will tell you of a theory I am maturing (by the way please do not mention it to anyone, for 2 directly opposite reasons, viz whether valueless or valuable). (DCOD, Letter 1856, 21 April [1856]).

Later in the same letter, after explaining some of his ideas, Darwin writes that, "Of course I cannot enter in details (& you would not care to hear them) on this subject, which I am sure in some degree would render the view more probable than it will seem to you at first" (DCOD, Letter 1856, 21 April [1856]). He then ends this partial preview of some of his ideas, concluding that, "There, I am sure, you will agree that I have prosed enough on my own doctrines; which I may have to give up, but I strongly suspect that the theory is a sound vessel & will hold water" (DCOD, Letter 1856, 21 April [1856]).

What does the example above reveal? Darwin seems to need to share some of his ideas, dangling them in front of colleagues like Bunbury. Not only does it partially sate his growing excitement that he is onto something with his theories and in fact has something of value, but it also defines his turf. It is a means of communicating pieces of the information in his possession, while protecting the composite whole of that future asset by not disclosing everything about it until the time is right. Quammen (2006) describes this behavior by using the analogy of a dog marking his or her territory, in recounting a claim-staking letter sent by Darwin to rival theorist Alfred Russel Wallace (p. 152). Claim-staking will be discussed in greater detail in the Darwin and Wallace case study below.

51. Dispersing: spreading and promoting information widely in the form of tangible items and intangible ideas.

Dispersing or the spreading of information, such as Darwin's ideas, was effectuated by his numerous writings and publications, which he wrote, presented, and published throughout his life. His abundant correspondence to peers and other persons throughout the world, well-documented in this dissertation, also helped to disseminate his eventual evolutionary theory by natural selection, via *Origin*. It is interesting to note as well, that this man who was fascinated by how seeds and organisms might be transported around the globe by ocean currents, atmospheric winds, and piggybacked animals, was equally adept at dispersing his intellectual seeds in the form of ideas, so effectively. An example of this information dispersing behavior will be discussed in the propagating section below.

52. Propagating: facilitating the dispersal of information by others.

Figure 23. *Das Kapital*, sent to Darwin and inscribed "Mr. Charles Darwin on the part of his sincere admirer Karl Marx". Photograph taken by permission of The Home of Charles Darwin, Down House, English Heritage.

Propagating is the last DIB that is identified and discussed in this dissertation because in some ways it signals the end of Darwin's own information behavior process. Yet it also represents a beginning as well. Once *Origin* was published, Darwin's peers who had read it and were persuaded by Darwin's arguments, such as zoologist Thomas Henry Huxley (nicknamed "Darwin's Bulldog" for his dogged support of Darwin's evolutionary theory), subsequently helped to spread its ideas. Darwin had succeeded in publishing *Origin* and that job was done. But the job of spreading his ideas was just getting started. To that end, Darwin helped to propagate his ideas via *Origin*, by dispersing his book to both potential supporters and nemeses. Many scientific peers, who had been unknown to Darwin before reading *Origin*, also became proponents of his theory. They contacted him through letters, to which Darwin responded, and subsequently became propagators of his ideas as well. Browne (2002) recounts one such supporter, "Ernst Haeckel, the German biologist and evolutionist, [who] was an ardent disciple…[and] was one of the first to construct evolutionary trees" (unnumbered photos and text). Zoologist George John Romanes was another who became a dedicated follower and proponent of Darwin's evolutionary theory. Karl Marx became an adherent of Darwin's evolutionary theory as well and mailed him an autographed copy of his book, *Das Kapital*, which is housed in the archives at Down House.

A letter, written three days after *Origin*'s debut, from Darwin to Thomas Henry Huxley presents a compelling example of these information dispersing and propagating behaviors, of which Darwin is keenly aware:

> I thank you particularly for telling me what naturalists think. If we can once make a compact set of believers we shall in time conquer. I am **eminently** glad Ramsay is on our side—for he is, in my opinion, first-rate geologist.— I sent him copy, I hope he got it— I shall be very curious to hear whether any effect has been produced on Prestwick—I sent him copy, not as friend, but owing to a sentence or two in some paper, which made

> me suspect he was doubting.— **Revd** C. Kingsley has a mind to come round. Quatrefages write that he goes some long way with me: says he exhibited diagram like mine—. (DCOD, Letter 2558, 27 November [1859]).

Footnote 8 notes that, "Andrew Crombie Ramsay provided the information on the depth of geological deposits that CD cited in *Origin* , pp. 284, 286. For Ramsay's favourable response to *Origin* , see *Correspondence* vol. 8, letter from A. C. Ramsay, 21 February 1860" (DCOD, Letter 2558, Footnote 8, 27 November [1859]).

L. CASE STUDY, THE WALLACE CRISIS OF 1858: HOW DARWIN'S INFORMATION BEHAVIORS SAVED *ORIGIN'*S PRIORITY

The objective of the following case study is to focus on a make-or-break month in Darwin's life: a crisis period when priority for his decades-in-the-making evolutionary theory by natural selection was nearly preempted, or at best halved, due to a fateful, unexpected postal delivery from the Far East. The time was June of 1858. The delivery consisted of a letter, and a manuscript of striking similarity to Darwin's evolutionary ideas. The sender was one Alfred Russel Wallace, who, like Darwin, was a British collector of specimens—and an observer of species. The appearance of Wallace's manuscript at Darwin's Down House sanctum sanctorum triggered a do-or-die call to action for the natural historian-cum-would-be-evolutionary theorist. Once his initial shock subsided, the manuscript's "striking coincidence" incited him to mobilize the fruits of his past and present information behaviors, as well as his guardian angels Joseph Dalton Hooker and Charles Lyell, in an 11th hour publish-or-perish strategy that would profoundly influence, if not outright save, the "originality" of his life's work and legacy (DCOD, Letter 2285, 18 [June 1858]).

However, before examining that June-July 1858 crescendo period for Darwin, some background and lead-up information is necessary. Probably no period of Darwin's life better demonstrates the profound impact and culmination of his information needs and behaviors upon his life's work than the several years preceding *Origin*'s publication in late 1859. In April 1856 Darwin's mentor Charles Lyell visited him at Down House. There, Darwin "told Lyell about his theory of natural selection as a mechanism for species change" in detail (DCOD, Letter 1862, May 1-2 1856, footnote 10). Lyell mulled Darwin's ideas over, "it looked horribly as if Darwin had a case" (Browne, 1995, p. 541). He was troubled by the religious implications of Darwin's theories "for the soul of man and his place in nature" but "though he never managed to accept everything Darwin was to propose, he wrote promptly to Down House to suggest that Darwin should publish" (p. 541). As Lyell's letter of May 1-2 1856 states, "I wish you would publish some small fragment of your data *pigeons* if you please & so out with the theory & let it take date—& be cited—& understood" (DCOD, Letter 1862, 1-2 May 1862).

However, Darwin was reluctant to publish before he felt ready to do so. It is helpful and relevant for better understanding Darwin's decades-long information behavior process to briefly examine why. One reason, Browne (1995) writes, was that "[i]t was far easier to carry on collecting facts, to keep busy, to say the work was unfinished, than it was to stop. If he stopped he would feel obliged to present it" (pp. 541-542). Another reason was fear: thoughts of publishing and presenting his theories made him apprehensive because of the public outcry he knew his ideas would evoke in Victorian Era society. He already knew first-hand how his ideas had impacted his wife Emma and feared the extent to which his publicly-revealed theories would continue to psychologically impinge upon her peace of mind, her devout belief in an afterlife that would likely exclude her evolution-espousing husband. He had also seen the adverse reactions to earlier transformationist writings, including his paternal grandfather's. Darwin was thus able to foresee the consequences his theory was likely to have on the public at large; a public that had been socialized to believe in a divine Creator and found comfort in believing God's creating hand was visible and omnipresent in all things, that saw nature as peaceful, aesthetically beautiful, and designed for man's purposes. Contrary to that view, however, "Darwin's view of nature was dark—black" (Browne, 1995, p. 542). Browne elaborates:

> At its most basic level his theory required a stunning readjustment of intellectual and emotional focus. Where most men and women generally believed in some kind of design in nature—some kind of plan and order—and felt a deep-seated, mostly inexpressible belief that their existence had meaning, Darwin wanted them to see all life as empty of any divine purpose. (p. 542).

Yet, Darwin understood the allure of the traditional, mainstream, benevolent view of nature, "he could still see the pleasure in finding a higher purpose in nature…He knew how hard it was to abandon such a view" (p. 542).

It was within this combustible backdrop of mixed feelings and charged emotions, a changeable cognitive landscape of alternating discomfort and evolving comfort with his own theories, and eventual acceptance of the maverick role he would necessarily be required to assume in order to put forth his theories publicly, that Darwin toiled and ruminated and revisited his facts and information again and again. Indeed, Darwin's letter to close friend and peer Joseph Dalton Hooker dated January 11, 1844, just after their correspondence relationship first began, pointedly exposes the inner turmoil that long plagued him. More to the point for this dissertation, though, this 1844 letter provides some insightful instances describing his information behavior-related work process. Analyzing Darwin's words expressed in that letter, reveals a range of Darwin's DIBs, which are inserted below, in brackets, after each example:

> I was so struck with distribution of Galapagos organisms &c &c & with the character of the American fossil mammifers, &c &c that I determined to collect blindly every sort of fact [hunting/searching, detecting/finding, collecting] , which c[d] bear any way on what are species [evaluating/relevance-determining].— I have read heaps of agricultural & horticultural books [reading, referencing], & have never ceased collecting facts [extracting/excising]. (DCOD, Letter 729, [11 January 1844]).

Other DIBs are evident in his concluding sentence too, in which he tells Hooker of the guilt-ridden burden he feels, at the growing realization of his work's ramifications: "At last gleams of light have come [reflecting, understanding], & I am almost convinced [understanding] (quite contrary to opinion I started with [revising]) that species are not (it is like confessing a murder) immutable [explaining]" (DCOD, Letter 729, [11 January 1844]).

Following his confessional letter to Hooker in 1844, it would be more than a decade before Darwin would definitively move forward in preparing for publication of any semblance of his theories. Even after Lyell in early 1856 had urged Darwin to write up his theories, Darwin resisted and put it off. "The task seemed too daunting on every score" (Browne, 1995, p. 541). In a May 3rd [1856] letter by Darwin back to Lyell, he expressed his dilemma:

> With respect to your suggestion of a sketch of my view; I hardly know what to think, but will reflect on it; but it goes against my prejudices. To give a fair sketch would be absolutely impossible, for every proposition requires such an array of facts…But I do not know what to think: I rather hate the idea of writing for priority, yet I certainly sh[d]. be vexed if any one were to publish my doctrines before me. (DCOD, Letter 1866, 3 May [1856]).

But gradually, Browne (1995) explains, Darwin became more comfortable with getting going with the task of memorializing his theories in at least some kind of written format (p. 543). As Browne (1995) cites, "Began by Lyell's advice writing species sketch, he recorded solemnly in his journal" (p. 543). Try as he might though, Darwin's progress was slow and disjointed. Chronic health problems repeatedly intervened. A perfectionist's temperament also impeded his laggard efforts at finishing the write-up. "I am like Croesus overwhelmed with my riches in facts," he told Fox soon afterwards, '& I mean to make my book as perfect as ever I can" (Browne, 1995, p. 543). Unbeknownst to Darwin, however, his plans for literary perfection were soon to be abandoned by the fateful arrival of a letter: a letter from another naturalist, named Alfred Russel Wallace, who was also thinking—and, like Darwin, writing—about evolution.

It was this very kind of situation which Lyell had feared in 1856—that Darwin might be preempted by another with similar if not identical ideas—when he had urged Darwin to publish *anything* on his theories (Browne, 1995, p. 541). On top of that, it seems both ironic and apropos that Darwin, who was writing about competition as a factor in natural selection, was now jolted out of his seeming isolation by Wallace, whose presence suddenly introduced a competitive pressure to the struggle for survival of Darwin's rights of priority for his scientific ideas.

Like Darwin, Alfred Russel Wallace was a naturalist who had explored parts of South America. He also had enjoyed a measure of financial success and notoriety in collecting specimens during his expeditionary travels. But following a number of nearly life-ending experiences, Wallace left South America and, after a period in England, eventually made his way in 1854 to the Malay Archipelago (DCOD, Letter 2004, Footnote 4, 29 November [1856]). Unlike Darwin, Wallace came from a more humble family lineage. He was not advantageously positioned to fall back on the benefits of social standing, benefits which provided a safety net but also a springboard for Darwin: namely, money, known and respected paternal and maternal family lines, membership in upper-crust London professional clubs, servants and assistants, and clever Cambridge mentors and peers with access to influential, career-enhancing scientific circles.

In short, Darwin and Wallace moved in different circles. As such their paths were not as likely to cross as Darwin's did with other scientific contemporaries.

Browne (1995) relates that Darwin and Wallace's paths did eventually intersect, reporting that they "had met briefly once, although it is not clear exactly when" (p. 537). Her research indicates that they met sometime before 1848 or sometime before 1854, both occasions preceding Wallace's departures for expeditions abroad (p. 537). But aside from that instance, Darwin's first contact with Wallace of a correspondence nature occurred in the mid-1850's, in conjunction with the ongoing cultivation of his global network of correspondents. The DCOD explains that Wallace's "name was included in CD's list of individuals to ask for specimens" (DCOD, Letter 2004, Footnote 4, 29 November [1856]). Darwin wrote to Wallace at his address in the Malay Archipelago in December of 1855. He had been provided with Wallace's address by another of Darwin's many correspondents. Unfortunately, the letter has not survived. But from other sources we know that in that letter, Darwin asked Wallace to send him the skins of foreign breeds of domestic fowl. Browne (2002) states that both Darwin and Wallace were pleased by the start of their casual correspondence (p. 30). A factor in Darwin's pleasure was a collector's incentive: "[a]s always, Darwin desired skins, bones, and information" (p. 30).

Another correspondent who supplied Darwin with specimens, also acquainted with Alfred Russel Wallace, was Edward Blyth. Blyth was a London zoologist who worked in the mid-1850's as a museum curator at the Asiatic Society of Bengal in Calcutta, India. The DCOD Name Register notes that he "[p]rovided CD with information on the plants and animals of India in correspondence between 1855–1858". Browne (2002) also writes that Blyth numbered among Darwin's acquaintances who "advocated some form of evolutionary change" (p. 22). So, it is not surprising then that Blyth's December 8, 1855 letter to Darwin comments on a paper of Wallace's titled "On the law which has regulated the introduction of new species" and asks

Darwin for his comments about it too. The paper had been published in the September 1855 issue of *Annals and Magazine of Natural History*: "What think you of Wallace's paper in the *Ann. M. N. H.* ? Good! Upon the whole!" (DCOD, Letter 1792, 8 December 1855). Blyth is positive regarding other aspects of the paper, with statements like "Wallace has, I think, put the matter well" and "A trump of a fact for friend Wallace to have hit upon!" Further, he discusses a section about the differing colors and physical traits of Asian animals in a compilation of Hamilton Buchanan's writings, pointing out that these animals "afford capital data for Mr . Wallace to descant upon, in reference to his views." Continuing, Blyth probes for Darwin's critical impressions and declares his high opinion of the value of an author's clear expression of compiled information: "What do you think of the paper in question? Has it at all unsettled your ideas regarding the persistence of species,—not perhaps so much from novelty of argument, as by the lucid collation of facts & phenomena."

In fact, Darwin saw works of compiled facts as having considerable utility for him. In a letter to J.D. Hooker written by Darwin sometime after January 20, 1857, he assessed an 1855 book of compilations by Alphonse de Candolle (a Swiss botanist with the historical first of having introduced postage stamps to Switzerland): "One must judge by one's own light, however imperfect, & as I have found no other Book so useful to me, I am bound to feel grateful: no doubt it is in main part owing to the concentrated light of the *noble art of compilation*" (DCOD, Letter 2033, [after 20 January 1857]). He evaluates the strengths and weaknesses of the de Candolle book, and thereby exhibits another of Darwin's DIBs, i.e. evaluating/relevance-determining, as well as the broad BCIB of information use. He goes on to state in what areas de Candolle's comments "will be very useful to me" and directly names an area where he thinks de Candolle "has made a great blunder".

The January 20, 1857 letter to Hooker is also significant as a Darwin correspondence example which specifically describes Darwin's work methods in his own words. This is best seen when he tells Hooker, "You know how I work subjects, namely if I stumble on any general remark [detecting/finding], & if I find it confirmed in any other very distinct class [verifying/confirming], then I try to find out whether it is true [verifying/confirming], if it has any bearing on my work [evaluating/relevance-determining]" (DCOD, Letter 2033, [after 20 January 1857]). With just this one sentence, Darwin has implicated several broad context information behaviors (BCIBs)—information seeking, information organizing, and information use. But as indicated by the DIBs noted in the brackets above, he mentions a number of his DIBs too.

Darwin's first extant letter to Wallace is dated May 1, 1857. In it he discusses Wallace's paper, which had appeared in *Annals* in 1855 and been recommended to Darwin by Lyell to read. The similarities were striking to Darwin: "By your letter & even still more by your paper in *Annals*, a year or more ago, I can plainly see that we have thought much alike & to a certain extent have come to similar conclusions" (DCOD, Letter 2086, 1 May 1857). Darwin also told Wallace that it was "the 20th year (!)", sharply emphasized via the exclamation mark, since he had first started working "on the question how & in what way do species & varieties differ from each other" (DCOD, Letter 2086, 1 May [1857]). He went on to tell Wallace that he was preparing to publish his work but did not expect to do so for two years (DCOD, Letter 2086, 1 May 1857). Desmond and Moore (1991) note that, "Wallace…was receiving the nicest kind of trespass notice. Shrewdly, Darwin staked his claim without giving his case away" (p. 455). Quammen (2006), as mentioned previously in the DIB claim-staking discussion, describes Darwin's warning statements to Wallace as akin to a male dog "raising his leg to mark a tree" (p. 152). He concludes that, "With its histrionic exclamation point, Darwin's remark was an assertion of his own interests, precedence, and claims" (p. 152).

Through the ensuing year, Darwin continued with his writing project. In September 1857 he wrote to Asa Gray, the American botanist and Harvard University natural history professor with whom he had been corresponding for several years. As with other trusted confidantes, Darwin cautiously divulged his ideas, by means of an abstract sent to Gray. Unforeseeable at the time, that abstract, which had first been written as a draft, recopied, and then sent to Gray, would assume an important evidentiary role for Darwin just ten months later:

> As you seem interested in subject, & as it is an immense advantage to me to write to you & to hear **ever so briefly**, what you think, I will enclose (copied so as to save you trouble in reading) the briefest abstract of my notions on the **means** by which nature makes her species. (DCOD, Letter 2136, 5 September [1857]).

Recalling this dissertation's earlier discussion of the DIB of claim-staking and its cited 1856 instance evincing this kind of territory marking behavior by Darwin vis-à-vis Lyell's brother-in-law, Charles James Fox Bunbury, Darwin arguably demonstrates a similar type of claim-staking behavior with Gray. Though Darwin does not overtly invoke priority as the reason for the discretion he requests in the following passage to Gray, it is likely an unstated concern for him:

> You will, perhaps, think it paltry in me, when I ask you not to mention my doctrine; the reason is, if anyone, like the Author of

> the Vestiges, were to hear of them, he might easily work them in, & then I sh d . have to quote from a work perhaps despised by naturalists & this would greatly injure any chance of my views being received by those alone whose opinion I value. (DCOD, Letter 2136, 5 September [1857]).

As it became evident all too soon, Darwin in fact did have good reason to be concerned about preserving priority for his ideas. In a letter by Darwin to Charles Lyell, dated 18 [June 1858], he informed his old mentor, "Your words have come true with a vengeance that I sh [d] . be forestalled" (DCOD, Letter 2285, 18 [June 1858]). Darwin recounted the arrival of a letter from Alfred Russel Wallace, accompanied by a manuscript entitled 'On the tendency of varieties to depart indefinitely from the original type' (DCOD, Letter 2285, Footnote 3, 18 [June 1858]). The tone in Darwin's letter conveyed a mixture of shock and surprise:

> "I never saw a more striking coincidence. if Wallace had my M.S. sketch written out in 1842 he could not have made a better short abstract! Even his terms now stand as Heads of my Chapters" (DCOD, Letter 2285, 18 [June 1858]).

Amidst this professional crisis, a personal one simultaneously added to Darwin's travails. A scarlet fever epidemic was sweeping the surrounding Downe village. Several children in the village had died and some of the Darwin children were showing symptoms. Tragically, Charles and Emma's 2-year old son, Charles Waring Darwin, their last child together, would ultimately succumb to the contagious affliction, dying on June 28, 1858. The other Darwin children were hastily sent away with Emma's sister to reduce their chances of catching the illness too.

Even in the midst of baby Charles's steady decline, Charles the father's mind whirred and pitched as he struggled to save his long-sought priority. Letters were hurriedly exchanged among Darwin, Lyell, and Hooker. Finally, one week after Darwin's initial letter to Lyell, the seeds of a survival strategy began to sprout. In a June 25th letter to Lyell, Darwin pointedly noted that:

> There is nothing in Wallace's sketch which is not written out much fuller in my sketch copied in 1844, & read by Hooker some dozen years ago. About a year ago I sent a short sketch of which I have copy of my views (owing to correspondence on several points) to Asa Gray, so that I could most truly say & prove that I take nothing from Wallace. (DCOD, Letter 2294, 25 [June 1858]).

He was cleverly thinking about how he could produce a paper trail: a chain of his prior writings that would establish his priority for arriving at his theory of evolution by natural selection well before Wallace. Importantly as well, he wanted to show that he had neither been influenced by nor unduly taken advantage of Wallace's ideas over the last few years of correspondence between the two men. Darwin articulated the dilemma to Lyell in that June 25th letter:

> I sh d . be *extremely* glad **now** to publish a sketch of my general views in about a dozen pages or so. But I cannot persuade myself that I can do so honourably. Wallace says nothing about publication, & I enclose his letter.— But as I had not intended to publish any sketch, can I do so honourably because Wallace has sent me an outline of his doctrine?— I would far rather burn my whole book than that he or any man sh d . think that I had behaved in a paltry spirit. Do you not think his having sent me this sketch ties my hands? (DCOD, Letter 2294, [25 June 1858]).

Just when it seemed Darwin's priority could be lost, or at best that it would have to be shared with Wallace, Hooker and Lyell came to the rescue. Through a fortuitous set of circumstances, they were able to arrange a joint reading of Darwin's and Wallace's papers at the Linnean

Society on July 1st. On the morning of June 29th Darwin wrote to Hooker to tell him that baby Charles had died the previous night (CCD, Vol. 7, 1858-1859, Letter 2297, [29 June 1858]). Later that day, having received a letter from Hooker, Darwin wrote back:

> I have just read your letter, & see you want papers at once. I am quite prostrated & can do nothing but I send Wallace [Wallace's manuscript] & my abstract of abstract of letter to Asa Gray, which gives most imperfectly **only** *the means of change & does not touch* on reasons for believing species do change. I daresay all is too late. I hardly care about it.— But you are too generous to sacrifice so much time & kindness.— It is most generous, most kind. I send sketch of 1844 **solely** that you may see by your own handwriting that you did read it.— I really cannot bear to look at it.— Do not waste much time. It is miserable in me to care at all about priority. The table of contents will show what it is. I would make a similar, but shorter & more accurate sketch for Linnean Journal.— I will do anything. (DCOD, Letter 2298, [29 June 1858]).

Footnote 5 states that "CD refers to the extensive table of contents prefixed to the fair copy of his essay of 1844 (DAR 113). On the third (unnumbered) page, he wrote in ink: 'This was sketched in 1839 & copied out in full, as here written & read by you in 1844'" (DCOD, Letter 2298, Footnote 5, [29 June 1858]).

Setting the stage for the Darwin and Wallace papers to be read to the Linnean Society members on July 1st, Hooker and Lyell wrote to the Linnean Society in a letter dated June 30th (CCD, Vol. 7, 1858-1859, Letter 2299, 30 June 1858). In it, they explained that Darwin and Wallace had independently and unknowingly "conceived the same very ingenious theory" (p. 123). They continued, stating that neither Darwin nor Wallace had published their respective ideas, although Darwin had "for many years past been repeatedly urged by us to do so" (p. 123). They concluded their rationale for presenting the papers of these two men by declaring that "both authors having now unreservedly placed their papers in our hands, we think it would best promote the interests of science that a selection from them should be laid before the Linnean Society" (p. 123). Of course, it was not entirely as above board as Hooker and Lyell's letter implied. Wallace, after all, was still thousands of miles away in southeast Asia, with no idea that the manuscript he had sent to Darwin was about to be presented to an august London scientific society.

Nevertheless, Hooker and Lyell's June 30th letter specified that three papers would be presented, "taken in the order of their dates" (p. 123). The first document was Darwin's so-called Sketch of 1844, which Hooker and Lyell described as "Extracts from a MS. work on Species, by Mr. Darwin, which was sketched in 1839, and copied in 1844, when the copy was read by Dr. Hooker, and its contents afterwards communicated to Sir Charles Lyell" (p. 123). Second, was a draft copy of the abstract that Darwin had sent to Asa Gray, the American botanist at Harvard. Hooker and Lyell described it as "An abstract of a private letter addressed to Professor Asa Gray, of Boston, U.S., in October 1857, by Mr. Darwin, in which he repeats his views, and which shows that these remained unaltered from 1839 to 1857" (p. 123). The third document was Wallace's "Essay", as Hooker and Lyell characterized it.

Stopping here briefly to look at the descriptions of the two papers submitted on Darwin's behalf, it is readily apparent that a number of information behaviors are implicated. Certainly, claim-staking permeates the entire process, the notion that Darwin and his peers are using information, i.e. the Sketch of 1844 and the copy of Darwin's 1857 letter to Asa Gray describing some of his species ideas, to assert Darwin's ownership or priority regarding his natural selection theory. Hooker and Lyell also understand that the broad context information behavior (BCIB) of information communication, that is the Sketch of 1844 having been communicated to Lyell, is an important point to underscore in advancing Darwin's priority. Also implicated is the DIB of reading, where Hooker is said to have read a copy of the Sketch. The DIB of dispersal is implicit too, as Hooker and Lyell seek to connote a sense that Darwin's ideas were being spread and promoted to others via the reading of his papers, even if it were only Hooker, Lyell, and Gray. Hence, it can be argued that a variety of information behaviors were used strategically by Darwin, Hooker, and Lyell to promote the case for Darwin's priority.

Moreover, an equally if not more important point is that Darwin's pre-Wallace information behaviors, i.e. those which which were engaged in by Darwin well before the June 1858 arrival of Wallace's manuscript and the subsequent "pleading" of Darwin's case before the Linnean Society on July 1, 1858, clearly facilitated the making of Darwin's case. Indeed, the fact that Darwin was able to get his hands, so to speak, on the Sketch of 1844 and his draft copy of the 1857 letter to Asa Gray, implies the presence of a variety of information behaviors: at the least, copying, filing/storing, and retrieving. But the descriptions provided also imply that other DIBs were evident in these circumstances as well, such as lending, reading, corresponding, marking/scoring, and so forth. Of course, when citing the statements of persons such as Darwin, Hooker, and Lyell as reliable, it is also necessary to point out that they occasionally made errors as well. Footnote 4 of Letter 2299 takes issue with Hooker and Lyell's statement above, regarding Darwin's sketch having been commenced in 1839. The footnote relates that:

> There is no evidence in the Darwin Archive that CD composed a sketch of his views in 1839: although some pages have been identified as a possible outline and draft of 1839 (Vorzimmer

1975), it was subsequently shown that these were written in 1842 (Kohn, Smith, and Stauffer 1982). Francis Darwin attributed the misdating to a lapse of memory on the part of his father (Foundations, pp. xvii-xviii). (CCD, Vol. 7, 1858-1859, Letter 2299, 30 June 1858).

Returning to the issue of how Darwin's information behaviors influenced this crisis period for his priority, it may be helpful to consider the alternatives. What if Darwin had not filed and stored papers like his Sketch of 1844 or preserved a copy of the draft letter he used to write to Asa Gray in 1857? What if he could not find and retrieve those papers once they had been filed? What if he had not loaned his Sketch of 1844 to his peers Hooker and Lyell, thereby making them aware of his work and initiating a long-term process whereby Hooker, Lyell, Gray, and others in essence could become advocates for Darwin's ideas and then help to disperse and propagate those ideas to others? Fortunately for Darwin's legacy, such questions are moot and hypothetical, because Darwin's information behaviors, in combination with the efforts of his peers and allies, were instrumental in preserving the priority of his evolutionary theory. He had weathered a crisis that had required him to mobilize his network of friends as well as his information resources. Now, he was favorably positioned to finish his "Big Book", culminating in *Origin*'s publication on November 24, 1859.

VIII. MODELS OF DARWIN'S INFORMATION BEHAVIORS

Two models were developed through the grounded theory and historical case study methods employed in this dissertation research. Figure 24 is a model of Darwin's Broad Context Information Behaviors (BCIBs). Five spheres representing Darwin's broad or general information contexts of seeking, organizing, managing, communicating, and use are situated within his encompassing Information Environment.

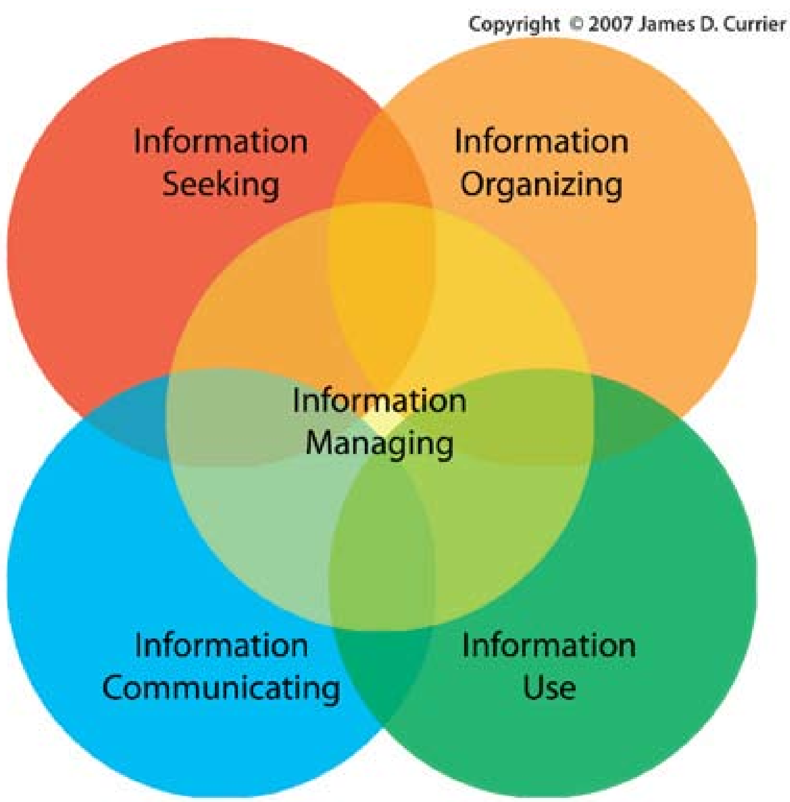

Figure 24. Model of Darwin's Broad Context Information Behaviors (BCIBs).

The Information Environment signifies the material space that Darwin inhabited throughout his personal and professional life stages, such as during the *Beagle* voyage, school and university, home, professional societies, and so forth. All five spheres overlap each other but also retain space, which does not intersect with other broad contexts. This overlapping signifies the interconnectedness of the five broad contexts with each other, which is juxtaposed by each broad context's non-overlapping space, signifying its individual characteristics. Different colors are utilized to highlight each sphere's uniqueness. Yet, where the spheres intersect, shared color represents their relatedness. The blank space around the five spheres can be viewed as symbolizing additional as-yet-unidentified broad context information behaviors, which may be identified through further research, and may be useful in framing, explaining, and depicting Darwin's information behaviors, and may be added to this model.

Figure 25 is a model of the five Broad Context Information Behaviors (BCIBs) and the fifty-two Descriptive Information Behaviors (DIBs), which were developed in this dissertation to classify and represent Darwin's information behaviors. The DIBs, like the BCIBs, were generated through this dissertation's grounded study methodology and historical case study methods. Figure 24 is duplicated within this model, with the addition of Darwin's fifty-two DIBs. In the upper right-hand corner of Figure 25, a Frequency Distribution histogram and a Percentage of Occurrences pie chart are provided.

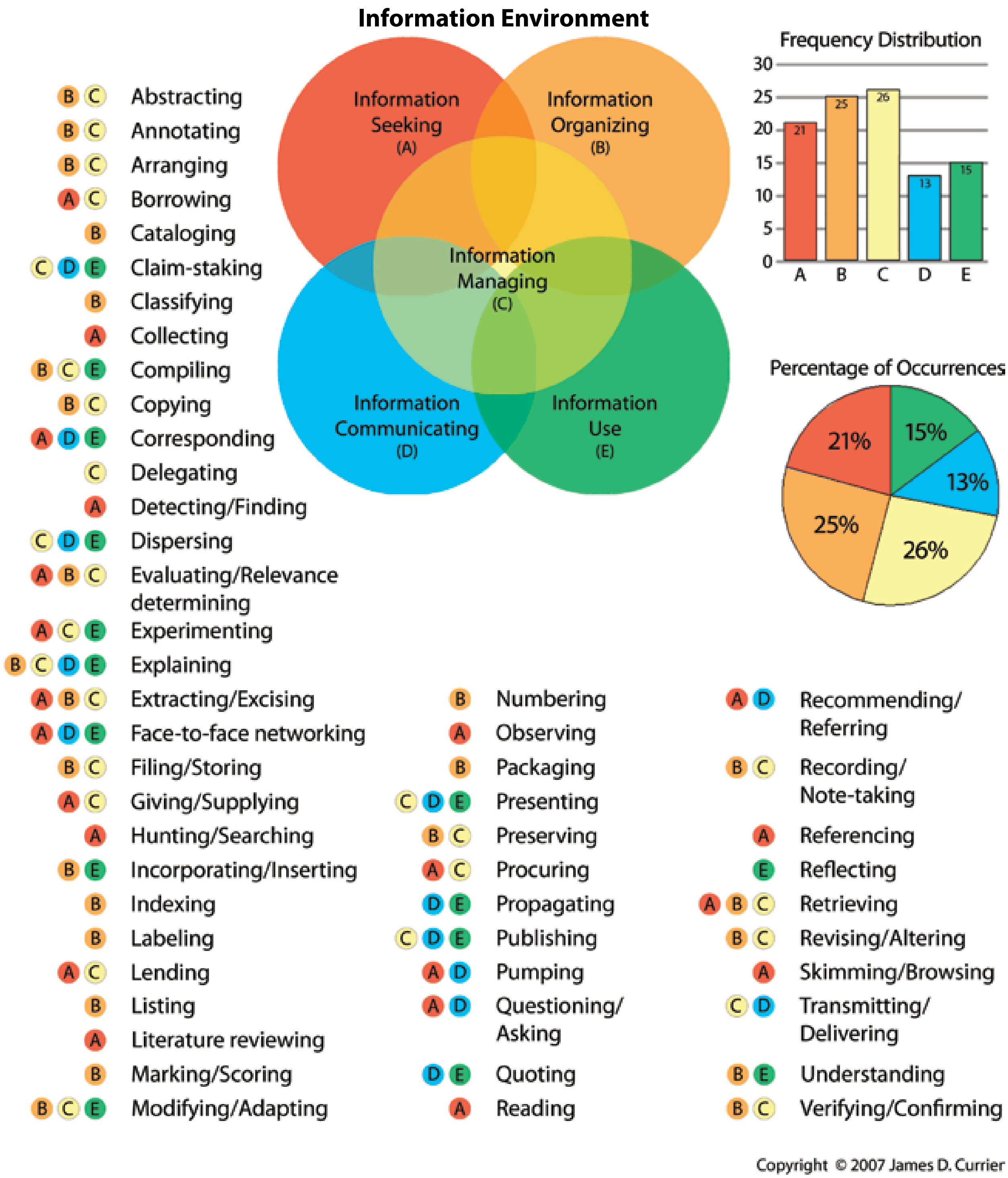

Figure 25. BCIBs and DIBs Model with Frequency Distribution histogram and Percentage of Occurrences pie chart.

The DIBs are conceptualized as subcategories that fall under the umbrellas of the BCIBs. Color coding is used to show the connection(s) of each DIB to its related BCIB(s). Each DIB relates to one or more of the BCIBs, as seen in Figure 25's example of the DIB Abstracting, which links to the two BCIBs of B. Information Organizing, and C. Information Managing. Figure 25 displays Darwin's five BCIBs and his fifty-two DIBs within a surrounding Information Environment, akin to the Information Environment description in Figure 24. Both models can accommodate additional BCIBs and DIBs, which may be identified and developed through further research.

The conceptualization and development of these models were informed by Darwin's "entangled bank" quote from *Origin of Species* (1859):

> It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and so dependent on each other in so complex a manner, have all been produced by laws acting around us. (*Origin*, 1859).

The relevance and significance of the "entangled bank" quote to this dissertation's two models in this section will be explained in the Conclusions section.

Figure 25 also presents a Frequency Distribution histogram and a Percentage of Occurrences pie chart to illustrate and quantify the relationships of the DIBs to the BCIBs. The histogram and pie chart both use information derived from the adjacent BCIBs and DIBs model to indicate the percentage of DIB occurrences in relation to each of the five BCIBs. The percentages of DIB occurrences vis-à-vis each BCIB are listed as follows, from the most number of occurrences to the least: Information Managing (26%); Information Organizing (25%); Information Seeking (21%); Information Use (15%); and Information Communicating (13%).

IX. CONCLUSIONS

Because of the nature of this dissertation's design as an exploratory examination, identification, inventory, description, historical case study, grounded theory methodology, and graphic depiction of Darwin's information needs and behaviors, many concluding observations and comments about Darwin's information needs and behaviors have already been presented in the preceding Discussion and Models sections. However, a number of additional conclusions, some of which build and expand upon points made in those sections as well as some that are original to this dissertation, can be made.

Firstly, Darwin's information behaviors can be better understood by classifying and looking at them macroscopically and microscopically in the metaphor of an information environment or ecosystem. This point is represented by the models that depict the broad context information behavior (BCIB) categories and the descriptive information behavior (DIB) categories, the latter of which can be seen as subcategories of the BCIB categories. As mentioned in the Discussion section, Darwin's information behaviors can be viewed at the macroscopic level via general or broad contexts, such as Information Seeking and Information Communicating. In a similar mode, Darwin's information behaviors can also be observed at the microscopic level, in terms of the DIB subcategories of those broader contexts, such as abstracting, networking, claim-staking, and so forth. Metaphors are beneficial for conceptualizing and explaining scientific concepts. Hence, it may be helpful to think about Darwin's information behaviors in conjunction with his "entangled bank" quote from *Origin*, which was cited in the Models section. The entangled bank can be seen as enabling a macroscopic and microscopic view, as well. Like the many and different organic forms that Darwin describes as inhabiting the entangled bank ecosystem, Darwin's information behaviors can similarly be seen as a mixture of simple (e.g. copying) and complex (e.g. classifying) behaviors. Just as *Origin*'s entangled bank describes the interdependency of the varied life forms situated within its environment and the hierarchical nature of the bank's relationships, such as plants to insects to birds, Darwin's information behaviors, too, can be interpreted as interdependent and ordered (e.g. classifying, cataloguing, and indexing; collecting, observing, and recording). The life forms of the entangled bank and the information behaviors making up Darwin's information environment are individual and diverse, yet share common features of kinship. *Origin*'s entangled bank also represents an iterative cycle of life that is influenced by greater forces and scientific laws. In the same fashion, Darwin's information behaviors represent an iterative life cycle of information, from, for example, beginning Information Seeking stages of Hunting, Searching, Finding, and Collecting through further developed stages, such as Understanding, Explaining, and Publishing, which are specific manifestations of Information Communicating and Information Use. Darwin's information behaviors are situated within and influenced by factors of his encompassing information environment, which included home, university, people and professional networks, travel experiences, and so forth, in the manner in which the entangled bank is also impacted by outside variables and factors.

Secondly, several key themes of Darwin's life resonate from this dissertation's findings. One of the strongest and most conspicuous of these themes is Darwin's need for order and arrangement, in nearly all professional and personal areas of his life. This theme is demonstrated through numerous DIBs which were explicated in the Discussion section. Some of these DIBs with an ordering component include recording/note-taking, annotating, abstracting, marking/scoring, labeling, numbering, listing, indexing, cataloging, classifying, preserving, arranging, filing/storing, retrieving, and compiling. The CCD further reinforces the ubiquity of ordering in Darwin's life:

> Darwin's careful records of his life and work reveal a methodical mind keen to establish order: he chronicled his health, his daily and household accounts, his scientific and personal activities… the behavior of his children…the books and journals he read… and his investments and financial transactions. Likewise he gathered and recorded everything he could find pertaining to species and varieties----information that was carefully classified and filed in numerous portfolios against the day when he would turn to writing up his theory in full. (CCD, Vol. 4, 1847-1850), p. 13).

Darwin's ordering characteristics were also apparent in anecdotal examples cited in this dissertation's Discussion section, which illustrated Charles and Emma's highly structured lives at Down House.

It is interesting to note, though, that Darwin's propensity for order and arrangement did not just insularly impact himself, his family, and those in his immediate information environment. Rather, from a global and longitudinal perspective, it can be argued that Darwin's tendencies for ordering and arranging impacted the entire planet, not only during Darwin's lifetime but, also, through the present. As discussed earlier in this dissertation, some facts and information bearing upon evolutionary theory existed prior to Darwin's entrance on the scientific stage. Indeed, predecessors of Darwin's, such as his grandfather Erasmus Darwin, and Jean-Baptiste Lamarck, made strides in teasing out and advancing aspects of an evolutionary theory. But these proto-evolutionary theorists were ultimately unable to accurately and creatively see missing links and make linkages of information, some of which was unavailable to them or was in error. Hence, Darwin's need and ability to order and arrange the information in his own information environment can be viewed as extending to a need and ability to redress and rearrange humanity's until-then collectively disordered, unarranged, unknown, and sometimes erroneous information related to the big question of how life on earth began. Darwin's information behavior-oriented contributions were to extract the evolution-relevant work of previous and contemporary researchers, verify what was right, revise or weed out what was wrong, order, arrange, incorporate, and combine that extracted, verified, and revised information with the information that he had generated from his own *Beagle* observations and recorded notes and his later reading, abstracts, annotations, experiments, input from correspondents, etc. Finally, he compiled and leveraged this substantial body of information into the published *Origin*, thereby facilitating that information's communication and use to a wide audience. In conclusion, a singular effect of Darwin's information behaviors was to (1) find missing or unknown information relevant to the fundamental question of organic life's origins, and (2) provide order and arrangement of that information, through an information process that explained and made that explanation understandable in ways that had likely not been previously conceived, and certainly had not been achieved and recognized.

Thirdly, another observation that emerges from studying Darwin and his information behaviors is that key components of his evolutionary theory can be seen as metaphorical of his information behaviors, whether intentional or unintentional. *Origin* explains that organisms survive and flourish by adaptation, and modification and adaptation are central aspects of the ways that Darwin organizes, manages, and uses information. Dispersal, another significant idea in Darwin's work upon which he experimented and reflected, is the means by which plants and animals migrate and spread across the world. Darwin's prolific number of publications and correspondence, similarly, helped to disperse and disseminate his ideas and theories throughout the world. Moreover, his views were further spread by disciples, such as Thomas Henry Huxley, Ernst Haeckel, George Romanes, Herbert Spencer, Karl Marx, and others, who propagated his ideas and theories. In many such cases, the propagators of Darwin's ideas also modified and adapted evolutionary theory to further their own objectives and world views. Darwin's evolutionary theory asserts that living beings which reproduce have a better chance of survival and passing on their traits and characteristics. This is also present, generally, in Darwin's broad information communicating and use behaviors. More specifically, this is observed in his information presenting, publishing, dispersing, and propagating behaviors.

A fourth conclusion from this research is that the identification, inventory, and description of Darwin's information behaviors offers insights not only into Darwin's scientific practices but also more broadly sheds light upon and catalyzes intriguing questions about how Victorian era and pre-modern scientists operated as an early information sharing community. Many of Darwin's letters and additional primary and secondary source materials indicate that the concept referred to in modern times as the invisible college—a network of persons who share information—was present and thriving in Darwin's era. Darwin clearly possessed, accessed, and maintained an invisible college of valuable information providers and sharers, such as academic peers Charles Lyell, Joseph Dalton Hooker, Asa Gray, Thomas Henry Huxley, and numerous others. His peers and contemporaries had their own invisible colleges, as well. But a feature which may have been exceptional about Darwin is his *invisible community* of information sharers and providers. Beyond the invisible college's narrower sense of a collection of academically-minded information sharers, the term invisible community more broadly captures the connotation of Darwin's receiving and sharing of information from people inhabiting different societal niches and strata—laborers, animal breeders and fanciers, farmers, librarians, booksellers and publishers, entrepreneurs, politicians, military persons, etc.

Fifthly, this dissertation provides some insights into the state of 19th century information organization and technology and Darwin's involvement with these issues. In the course of focusing on Darwin and his information behaviors, a number of simultaneously occurring systemic library- and information-related issues also come into view: the development of academic, public, commercial, and governmental libraries, increases in published materials, such as scientific and technical literature that is being produced by a burgeoning British Empire, institutional collection matters, challenges with standardizing cataloguing and classification rules, and so forth. This leads to the observation that Darwin, though not a high profile policy maker in the United Kingdom's library and museum communities, must be recognized as an active, informed, contributing participant to an information dialogue and sea change that is occurring in Britain and around the world: an innovative metamorphosis in the ways that information is being conceptualized, harnessed, and, frequently, used for commercial purposes. Indeed, information during this Industrial Revolution period can and needs to be seen as comparable in importance to natural resources and goods of commerce, helping to provide the ingredients for the Empire's economic and technological development and superiority. Darwin's place amidst this information revolution is especially evident in the 1850's and 1860's, as letters in the DCOD and CCD reveal him as one who is both invested and involved in British libraries and the business and use of information: advising libraries on recommended books, seeking and requesting books to borrow, interfacing and corresponding with librarians such as Richard Kippist at the Linnean Society of London, conferring with his long-time book publisher John Murray about publishing runs and marketing of Darwin's books, engaging in spirited debates with nomenclature reformer Hugh Edwin Strickland about classification rules and taxonomical controversies, advocating for collection integrity along with Roderick Impey Murchison, a geologist and the President of the Royal Geographical Society of London from 1843-1858, to keep the British Museum's natural history collections from being split up and moved to different locations.

A sixth conclusion is that Darwin's information behaviors need to be considered as phenomena that were not just functions of Darwin as an individual toiling alone but were also functions of the influences, actions, and contributions expended upon Darwin by others. Mentoring and collaborating are two ways that these persons impacted Darwin's information behaviors and his work. As an example, mentors, such as John Stevens Henslow and Charles Lyell, afforded Darwin access to seasoned researchers, whose own information behaviors Darwin was able to observe, learn from, and model. Such mentors gave invaluable critical feedback and advice to Darwin, too, as demonstrated, for example, by Lyell's evaluative comments and suggestions about Darwin's collecting and recording practices, which were written to and received by Darwin during the *Beagle* voyage. Collaborating with others was also an important influence on Darwin's information behaviors and his research. Questioning and pumping peers like Joseph Dalton Hooker and others for information, corresponding and networking with the *Beagle* specimen cataloguing subject specialists, such as John Gould and George Waterhouse, and fellow researchers throughout the British Empire's holdings as well as academics around the globe to obtain facts and specimens, etc., gave Darwin opportunities to collaborate and interact with other scientists. In addition to providing him with information, it is likely that such exchanges and interactions influenced Darwin's information behaviors in both subtle and significant ways, some of which were identified in this dissertation. In sum then, Darwin's information behaviors and scientific life's work are not simply the result of this one man; rather, they need to also be seen as having been environmentally impacted by many persons within Darwin's spheres of influence.

Seventhly, the findings of this dissertation may suggest that Darwin's information behaviors were exceptional in some ways, in comparison with other scientists from his time period. However, it is essential to emphasize that more research needs to be conducted on the information behaviors of scientists from Darwin's era before such a conclusion could be substantiated. Many of the letters that are excerpted and presented in this dissertation indicate that other scientists and persons in Darwin's time period similarly manifested information behaviors, such as collecting, observing, recording, corresponding, and so forth. Moreover, scientists predating Darwin manifested information behaviors and exhibited evidence of their information behaviors, such as Carolus Linnaeus, the 18th Swedish botanist, zoologist, and scientific classification innovator, who attained some information through correspondence. A more cautious, narrowly tailored conclusion is that the breadth of Darwin's information behaviors and the integrated manner in which he performed his information behaviors may have been factors that gave him a competitive edge over his rival evolutionary theorist, Alfred Russel Wallace. Darwin's advantage is evident in terms of the development of a fairly well-formed evolutionary theory before Wallace apparently did so. His edge is also apparent, even more consequentially, in Darwin's being able to prove by means of documentation that his written ideas predated Wallace's. This documentary evidence derived from writings which Darwin had produced in 1844 and 1857, and filed and preserved at Down House, until they were later retrieved and presented by Charles Lyell and Joseph Dalton Hooker on Darwin's behalf at the Linnean Society of London on July 1, 1858.

An eighth conclusion which emerges from this research is that Darwin's information behaviors were diverse and that he appears to have been able to move back and forth in performing and administering a large number of information behaviors. It cannot be said that he multi-tasked in the way that term is conceptualized today, as performing different tasks at the same time. However, the evidence from Darwin's letters and other primary and secondary sources suggests that he was able to conduct a wide variety of tasks in chronological proximity to one another. As the Darwin/Wallace crisis of 1858 showed, as explained in the Discussion section's case study, one of the key factors in Darwin's ability to preserve the originality of his ideas over Wallace was his skill in all five BCIBs—information seeking, organizing, managing, communicating, and use—and his adroitness in performing the fifty-two DIBs that were identified in this dissertation. It is noteworthy to point out, as well, that Darwin's information behaviors such as questioning/asking, corresponding, and networking essentially created an early warning detection system by means of his decades-in-the-making global information network. This network enabled him to detect Wallace's presence and "threat" before Wallace had published, and, hence, gave Darwin a significant competitive advantage, upon which he deftly capitalized.

A ninth conclusion from this research is that creativity was important to Darwin's information behaviors, work, and achievements. Darwin's autobiography identifies creativity in the penultimate sentence listing the factors—including "a fair share of invention"—that were most important to his "success as a man of science" (Barlow, 1958, pp. 144-145). Recently, Walter Isaacson (2007) was interviewed on National Public Radio about his new biography, *Einstein: His Life and Universe*. Isaacson asserts that many people were as brilliant as Einstein but that it was his creativity that distinguished him from others who were equally brilliant and capable. Einstein was able to think outside the box to imagine a new paradigm that was not bound by past thinking and the Newtonian status quo. A similar conclusion is applicable to Darwin's information behaviors too. Some of the information behaviors that Darwin performed at various times in his life were the same types of information behaviors that his peers and mentors were performing too, such as classifying facts and collecting rock specimens. An example from Darwin's son Francis Darwin, cited in the rationale section of this dissertation, noted Charles Darwin's and Alphonse de Candolle's similar method for classifying facts. Another example comes from Darwin's reflection later in his life on the important geological insights that he had gained from his Cambridge geology professor, Adam Sedgwick, during a shared field expedition to Wales in 1831, before he set sail on the *Beagle* later that year. Sedgwick, John Stevens Henslow, Charles Lyell, and others served as role models for Darwin. They provided him with advice and critical feedback on how to collect, record, preserve specimens, etc. It is likely that, to varying degrees, they influenced Darwin's information behaviors. But in other ways, the historical record indicates that Darwin displayed considerable creativity in the exercise of his information behaviors. One such area was Darwin's networking behaviors. Primary and secondary Darwin sources show that Darwin interfaced with people from all walks of life and social classes in order to obtain information. Given the rigid class lines in Britain, both then and even now though to a lesser extent, Darwin's inclination to disregard such class barriers, to step out of his own social setting and into that of others like pigeon breeders and farmers, was novel and resourceful. It showed inventiveness on Darwin's part, an active willingness to go where the information was, and engage in unconventional methods for acquiring information..

A tenth conclusion is that the majority of Darwin's letters and writings that were examined in this dissertation demonstrate Darwin's passion for information as he strove to attain facts, information, and specimens throughout his life. In truth, this passion for information theme is best epitomized by the "I am greedy for facts" letter that gave this dissertation its title. Yet at times Darwin's statements also demonstrate a type of information overload. This can be seen in Darwin's letter to his cousin William Darwin Fox, also cited in the DIB of Quoting in the Discussion section above, where he tells Fox that he is "*over* facted" (DCOD, Letter 2230, 28 February [1858]). Other Darwin letters and secondary sources convey further instances in which Darwin talks of being overwhelmed with the information that he has collected for decades, almost to the point of paralysis as to how to proceed with his analysis and discarding or incorporating of that information. It might, therefore, be interesting to examine and track different times when Darwin is overloaded by the information that he has acquired in order to potentially ascertain how he manages, or does not manage, such periods of information overabundance. Studying how Darwin perhaps utilized various types of information technology to organize his surfeit of facts, information, and specimens, and thus alleviate periodic information deluges might be enlightening, as well.

This final conclusion makes several important points, while also suggesting some challenging and thought-provoking questions. Some of these points and questions will be addressed in more detail in the Areas for further research section. This dissertation is not able to address at this time whether Darwin's information behaviors were unique within his time period. As mentioned earlier, more research needs to be done on Darwin and his other scientific contemporaries before any conclusion of that nature could be validly made and supported. Additionally, this dissertation is unable to definitively explain and substantiate whether Darwin's information behaviors can be seen as possibly having been influenced or benefitting from a fortuitous window of opportunity that may have been occurring in British society at large, stemming from the burgeoning Empire's technological advances that were happening in the mid-1850's in conjunction with the Industrial Revolution. Stated more simply as queries: were Darwin's information behaviors extraordinary, in comparison with others in his peer group? Were Darwin's information behaviors innately superior and/or environmentally enhanced by various factors, or was his success and prowess more a facet of being in "the right place at the right time in history" to take advantage of industrial and information-related technological advances that were transpiring during the 19th century chronological period in which he lived? These questions are beyond the scope of this dissertation but raise some intriguing areas for future research. What can be reliably asserted and substantiated at this time, however, is that Darwin's intense desire for facts and information and the information-related behaviors which he performed throughout his lifetime, in combination with other factors, were instrumental to his achievements and success as a man of science. Darwin's scientific and historical legacy is undoubtedly and inextricably yoked to evolution and his groundbreaking evolutionary theory by natural selection; but, as this dissertation has described and demonstrated, that legacy is one that must also be seen as unequivocally linked to, dependent upon, buttressed and fortified by the facts and information that fired Darwin's passion and imagination, and forever changed the world.

X. LIMITATIONS

As with all research, this dissertation has a number of limitations, which, along with some qualifications, are noted. Firstly, this dissertation is not an exhaustive examination of all extant Darwin letters and writings. Therefore, as a qualification, future research may identify Darwin-related information behavior categories in addition to the ones presented in this study. The DIB categories, which were explained and supported by data that was described and cited in this dissertation, were identified and derived from analysis of Charles Darwin's letters and writings and supplemented by scholarly Darwin secondary sources, as referenced. However, these DIB categories reflect the subjective judgment of the researcher and opinions will likely vary regarding whether some category headings should have been named differently, conflated, bifurcated, omitted, or added.

One limitation of this dissertation is its focus on one individual, which may limit generalizability. The BCIBs and DIBs developed through this study were derived from the writings and work of Darwin. Consequently, they are specific to him. However, though they relate specifically to Darwin's own information behavior thoughts and actions, it is likely that other individuals may share some of these information behaviors in common with Darwin. As a case in point, some of Darwin's information behaviors share some common features with the information seeking activities of Ellis et al.'s (1993) social scientists, physicists, and chemists, such as extracting and verifying, even though they are from differing time periods. Ellis et al. also identified a behavior which they termed chaining, for which some evidence was found for Darwin in a secondary source. Hence, not only may the BCIBs and DIBs identified for Darwin have some applicability and be useful for studying others in his peer group and/or non-peer scientists of his time period, but they may also be applicable to and instructive in studying the information behaviors of scientists from earlier and later time periods.

Another limitation pertains to the accuracy of the interpreted meaning of Darwin's statements or those of other correspondents referenced in this dissertation. In short, just because Darwin's statements indicate that he performed a certain action or stated something, does not mean he in fact did. A case in point is an 1849 letter in which Darwin wrote to Joseph Dalton Hooker that the latter's letters having "portions which did not contain any facts which I wanted to refer to again have been spitted & the other parts put in my portfolios" (DCOD, Letter 1239, 9 April [1849]). However, an accompanying editorial footnote states that there is no evidence that Darwin "spitted and divided" Hooker or Lyell's letters (DCOD, Footnote 3, Letter 1239, 9 April [1849]). Again, though, the footnote also adds that "not all the surviving letters are complete", so the issue remains unresolvable (DCOD, Letter 1239, Footnote 3, 9 April [1849]).

Another limitation of this research relates to Darwin's famously illegible handwriting. Its illegibility essentially requires the use of edited and transcribed publications of Darwin's writings and letters by anyone who is not expert in reading and deciphering Darwin's handwriting. Even those closest to him found his handwriting to be challenging. An amusing but insightful passage demonstrates this point. In an 1839 letter by Darwin to his fiancée, Emma, shortly before they were to be married, he refers to Emma's comments about his handwriting:

> And this puts me in mind to give you another *scolding* for sending me those *square* little sneers about my writing.— who ever read hieroglyphics, without the context, & is not my hand more like hieroglyphics than common writing? Bad hand as it is, it serve me to tell you, you are my own dear Emma, & there is an end of my *scolding!* (DCOD, Letter 484, 6-7 January [1839]).

Scholarly opinions vary on his handwriting's legibility. Curiously, Armstrong (1985) finds that, "His writing is generally quite legible, although the modern eye has difficulty with the occasional word: he seems sometimes to have written at considerable speed" (p. 8). However, Vorzimmer (1977) states that, "Although the penmanship of Darwin's amanuensis was excellent, Darwin's own hand is very difficult to read" (p. 109). Relating the "problems" in transcribing Darwin's reading notebooks, he explains that, "Darwin usually had more than 25 lines to a 7-inch notebook page. Since his writing is hard to read and often indecipherable without the constraints of such size, the reading of these holograph notebook pages was extremely difficult" (p. 109). Nicholas and Nicholas (2002) concur, discussing Darwin's first comments about Australia, which he recorded in a notebook: "Written on the impulse of the moment, and often in a great hurry, the words are not easy to decipher, and some are illegible" (p. 23).

Darwin's handwriting's illegibility would appear to be the consensus: familiarity with a large number of Darwin primary and secondary sources during this dissertation indicated that a majority of researchers view Darwin's handwriting as challenging, and in some instances, noted by transcription, impossible, to decipher and understand with certainty. Thus, reliance on transcribed and edited publications of Darwin's correspondence, such as Cambridge's definitive print CCD volumes or the electronic DCOD and CWCDO, is highly advisable and, from the experience of this dissertation, requisite. Indeed, first-hand experience examining Darwin's original notebooks and letters at Cambridge, as well as perusal of copies of Darwin's letters housed at the American Philosophical Society Library, reinforced the comprehension difficulties and potentially grave interpretive problems inherent in analyzing Darwin's unedited and untranscribed writings. In addition, misspellings and other grammatical issues in Darwin's writings may similarly present obstacles to confident understanding and reliable interpretation. Browne (1995) notes, for instance, in a passage discussing the types of fish that Darwin ate on the *Beagle*, that barracuda was "spelled "Barrow Cooter" in Darwin's diary" (p. 222). Armstrong (1985) notes that "His spelling is not altogether consistent" (p. 8). An editorial note on one of the Darwin letters examined in this study also stated that Darwin's own insertion of a punctuation mark made the meaning of that particular passage ambiguous to him years later upon his referral to it. Armstrong (1985) observes in this case as well that, "His punctuation and use of capital letters sometimes appear fairly arbitrary" (p. 8). A more substantial result of such problems in interpreting Darwin's handwriting is that in some cases indecipherable words have had to be conjectured by Darwin authorities, which also injects validity issues.

Another argument for the importance and necessity of reading transcribed and edited versions of Darwin's letters is his habit of not dating letters. As Armstrong points out, "Charles didn't always give the full date" (p. 8). Hence, as explained earlier, Darwin experts have had to use other relevant cross-indexing Darwin sources to attempt to date undated letters as accurately as possible. The Introduction to CCD, Vol. 7, 1858-1859 offers an illustrative example:

> As was his custom, Darwin did not supply a full date on his letter to Lyell. He simply dated the letter "18" and referred to Wallace's letter as having been received "today". Following Francis Darwin (*LL* 2: 116—17) and relying on Charles Lyell's endorsement, the editors have dated the letter 18 [June 1858]. However, the accuracy of Darwin's words has been questioned by John L. Brooks and by H. Lewis McKinney, both of whom believe that Darwin received Wallace's communication before 18 June. (pp. 5-6). http://www.lib.cam.ac.uk/Departments/Darwin/intros/vol7.html, accessed October 2, 2006.

In addition to not consistently dating his letters, Armstrong (1985) notes that Darwin was sometimes mistaken as to the dates he wrote, though "very rarely" (p. 8). He provides an example, showing that, "a page of his notes on the Cocos-Keeling Islands is dated 1835, yet in fact he visited that archipelago in April 1836, *after* having visited Western Australia" (p. 8). The DCOD editorial footnotes also note various errors that Darwin made in his work. As discussed with regard to Darwin's verifying and confirming information behaviors, though, he was generally diligent about avoiding the making of errors, noted the errors of others' writings, and evinced through his words and actions an inclination to correct his mistakes as expediently as possible.

XI. AREAS FOR FURTHER RESEARCH

This dissertation identified, inventoried, described, and depicted a significant amount of Charles Darwin's broad and specific information needs and behaviors. A large number of research topics and questions with connections to Darwin and information-related issues remain to be studied. Several areas for further research, related to and arising out of this study of Darwin's information needs and behaviors, are identified and discussed in this section. One potential area is to examine changes and developments in Darwin's information behaviors over the course of his lifetime. This issue was posed as a research question for this dissertation. Several examples suggesting some development in certain information behavior-related skill sets of Darwin's, principally as self-reported by Darwin, were noted. However, once the study was underway it became apparent that such a substantive and longitudinally-oriented question was beyond the scope of this research. One reason for this is that not all of Darwin's extant correspondence and writings have been transcribed, edited, and made available for scholarly research. Namely, the years 1868-1882, approximately 15 volumes, of Darwin's letters remain to be published by Cambridge University. Until all of this documentary evidence is available and accessible, reliance upon and use of these untranscribed, unedited, and unpublished letters presents potentially questionable interpretive validity, due to reasons such as Darwin's difficult to read handwriting and lack of clarity about the meanings of markings and annotations on many of his letters, which may substantially impact and impinge upon accurate comprehension of the unpublished letters' content and context. .

Incomplete electronic accessibility to the Darwin correspondence data via the DCOD presents other challenges too. At the time that this dissertation was prepared for doctoral defense submission in April 2007, not all of the Darwin correspondence was available electronically on the DCOD in full-text, although free text or keyword searching has been available since January 2007. Currently, only the years 1837-1859 are full-text accessible on the DCOD. Thus, until the remaining years are full-text accessible, researchers must rely upon the CCD print volumes. This presents both advantages and disadvantages, as was discussed earlier in the data collection section where the DCOD, CCD, and CWCDO Darwin resources were compared and contrasted. It is anticipated, according to the DCOD's homepage, that eventually the remaining years will be full-text accessible too.

This dissertation focused upon Darwin's correspondence to identify his information needs and behaviors and primarily collected and analyzed data from his letters through electronic access to the DCOD. Other electronic databases pertaining to individuals with whom Darwin had relationships, such as zoologist Thomas Henry Huxley, afford various research opportunities. For example, Clark University's Huxley File offers access to zoologist Thomas Henry Huxley's articles, books, and published letters at http://aleph0.clarku.edu/huxley/, which was accessed April 1, 2007. Huxley's letters may be useful for studying issues related to Darwin. Archival materials of additional Darwin scientific contemporaries may be beneficial for research on Darwin or they could be employed for a comparison study of Darwin and other scientists.

More and more electronic resources with links to Darwin are becoming available, such as Emma Darwin's diaries, according to a March 12, 2007 BBC article entitled "Darwin's wife's diaries go online". http://news.bbc.co.uk/2/hi/uk_news/6440599.stm, accessed April 1, 2007.

Issues of generalizability and applicability of this dissertation's BCIBs and DIBs to other persons were discussed as potential limitations in the Limitations section above. It might be worthwhile to study how the BCIBs and DIBs from this research, as well as the information seeking activity categories of Ellis et. al. (1993), for example, could be used to study the information behaviors of different persons. For example, as one possible area for further research it would be interesting to see what information behaviors were manifested by Darwin's peers, such as Hooker, Lyell, and Huxley, and how those compare and contrast with Darwin's. In this research stream, moreover, it would be enlightening to study how the information behaviors of Darwin and his evolutionary theory rival Alfred Russel Wallace were similar and dissimilar. A study of that nature might shed additional light on how Darwin was able to arrive at his evolutionary theory earlier and establish priority for his ideas over Wallace, as was detailed in this dissertation's Darwin/Wallace case study.

Almost any of the fifty-two descriptive information behaviors (DIBs) identified in this dissertation could justify an entire in-depth study of its own. An especially intriguing topic for this kind of focused study would be to delve more into Darwin's letter writing practices and his global information correspondence network, which were described in the Discussion section. The postal service was the principal means through which Darwin procured and transmitted information throughout his life. A host of engaging research questions could be investigated on this subject: In what ways did Darwin use the postal service to send and receive information? What were the characteristics of Darwin's postal service use during the *Beagle* voyage? How, specifically, was Darwin able to receive postal deliveries of books like volumes 2 and 3 of Lyell's (1830-1833) *Principles of Geology*, equipment, correspondence, etc., from his family and friends in England throughout the *Beagle*'s 5-year voyage around the world? What were the monetary costs involved in Darwin's ample postal service use for sending and receiving information and how was that use facilitated by his social class standing and financial status? How did the postal service of Darwin's era differ from that of previous periods? Looking at corresponding more broadly, how does research about Darwin's corresponding fit into the history of correspondence literature? Returning to the Darwin/Wallace case study described in this dissertation, what was the role of the postal service in Darwin and Wallace's communication by correspondence in the pre-*Origin* 1850's when Darwin was in England and Wallace was in the faraway Malay Archipelago? How did the significant time it took for Darwin and Wallace to receive letters from one another while Wallace was collecting specimens in Southeast Asia influence their information exchange and Darwin's ability to achieve priority for his evolutionary ideas? Regarding Darwin's global correspondence information network, it could be worthwhile to track its growth and development. Did Darwin's scientific peers have similar correspondence networks or was his unique?

Numerous topics radiating from this research have a library, archival, or information science component to them. An essential function of libraries and archives is filing and storing information and these were important activities for Darwin, too, as cited in the Discussion section's analysis of Darwin's filing and storing behaviors and the Darwin/Wallace case study. Studying Darwin's filing and storing methods at Down House and the influences on those information behaviors could help to explain how he maintained and retrieved his print resources. Tracking Darwin's use of academic, commercial, and professional society libraries, such as Cambridge University, 'Mudie's select library' in London, and libraries within private clubs and professional societies like the exclusive Athenaeum Club would be a worthwhile topic for inquiry, not only with regard to Darwin but to illuminate the existence and growth of different kinds of early libraries. For example, Darwin, in an 1846 letter to botanist Joseph Dalton Hooker, extols "how good a Public Library" Edinburgh has, while recalling his experiences there as an Edinburgh University student (DCOD, Letter 826, [10 February 1845]). Darwin's statement raises the question as to what he felt the characteristics were which made a public library, or any library for that matter, "good"?

Continuing with the theme of libraries, it could be productive to further explore Darwin's interactions with librarians. What influences, for example, did librarians have on Darwin and his work? This dissertation examined extant letters exchanged by Darwin and about a dozen librarians, which are indexed in the DCOD under the heading "librarians". Several instances of Darwin's interfacing with librarians are identified in this dissertation. One is Richard Kippist, who was a librarian with the Linnean Society of London; an example of their dealings, in which Darwin comes up against Kippist's book borrowing limits, is referenced in the description of Darwin's detecting/finding behaviors in the Discussion. Tantalizingly, two 1881 letters survive between Darwin and John Shaw Billings, a librarian and U.S. surgeon who would become the director of the New York Public Library and whose unique classification system for that library was retired in 2006. But the letters solely pertain to Darwin's permission for Billings and a surgeon colleague to call on Darwin at Down House. Anthony Panizzi, who was the principal librarian at the British Museum from 1856-1866 and significantly influenced cataloguing there, is included in the DCOD's index of librarians, but no extant letters between Darwin and Panizzi are present. During this dissertation's research trip to Britain in March 2006, the British Museum was visited and Darwin's name was observed amidst a large group of persons who had received Reader's Tickets for the British Museum. Hence, Darwin may have had encounters with Panizzi during his visits to the museum, which are not evidenced by the extant Darwin correspondence record. The Darwin letters also include some letters between Darwin and Charles Babbage, well-known and celebrated in LIS circles for his calculating machine, which is seen as a precursor of the 20th century computer. The nine surviving Darwin and Babbage letters are all written by the former to the latter between 1837 and 1842 and chiefly relate to Babbage's London parties for the well-heeled, well-connected set, which Darwin and his family occasionally attended throughout Darwin's years of residence in London after the *Beagle* voyage. Some of the Darwin letters between Darwin and other correspondents refer to Babbage, as their paths crossed at various societies such as the British Association for the Advancement of Science (BAAS). In one particularly memorable and humorous instance, Darwin, writing to geologist Charles Lyell in an 1838 letter, mentions a brouhaha between Babbage and another member of the BAAS over whether Babbage would serve as President of an upcoming meeting, which later leads to Babbage's life-long withdrawal from the association. Commenting on the parties' machinations and power struggles, Darwin wittily weighs in against Babbage, declaring, "what a grievous pity it is that the latter should be so implacable, & if one might so call the calculating machine, so very silly"

(DCOD, Letter 428, [14] September [1838]). The crux of this reciting of some of the research that was conducted for this dissertation vis-à-vis Darwin and several figures with library and information connections, though, is that Darwin's interfacing with librarians and early pioneers of information technology is a topic that clearly merits additional study. Again, as in the preceding passage talking about Darwin's use of libraries, studying Darwin's relationships with librarians and information figures might provide better understanding of his information behaviors. This may yield additional insights into the state of librarianship and information technology development in Victorian era Britain, too, during a nascent period for the library and museum professions and libraries of all types.

This dissertation touched on some instances of Darwin's book borrowing, but, certainly, much more is left to mine in this fascinating area. For example, what were the patterns of Darwin's book borrowing? How does Darwin's book borrowing dovetail with the development of libraries in 19th century Britain? In what ways was Darwin's book borrowing and access to print materials facilitated by the burgeoning publishing of the economically ascendant British Empire? During this dissertation, some brief research was conducted to determine whether Darwin's information behaviors, such as hunting/searching, cataloguing, filing/sorting, arranging, indexing, etc., might have been influenced by his experiences at libraries during his youth at boarding school and his college years at Edinburgh and Cambridge. Little was found on that topic during this dissertation, but it warrants further research. Determining whether Darwin was a "born packrat" or a "gentleman librarian", some of both, or something altogether different, could also be enlightening. Other potential studies might explore how Darwin's information organizing strategies relate to the development of classification schema, such as

Melvil Dewey's, and where Darwin is situated on a spectrum between, for example, Thomas Jefferson's library and information organization practices and those of Dewey.

One of the most obvious areas for further research emanating from this dissertation is to identify more of Darwin's information behaviors. With regard to the BCIBs, five contexts—information seeking, organizing, managing, communicating, and used—were identified and used for grouping and framing Darwin's information behaviors and representing the larger information environment in which he lived and worked. However, other BCIBs might also be identified through further research, which could prove useful for studying and framing Darwin's information behaviors. Regarding the DIBs, during the course of this dissertation, the list and number of identified DIBs exhibited by Darwin grew substantially, right up until the final preparation of this dissertation for defense. Consideration, in fact, was briefly given to identifying additional information behaviors which were hinted at by the data and secondary sources. For example, Ellis et al. (1993) discuss an information seeking category termed "chaining" to describe the reference practice of the scientists in their study who followed a chain of sources from one to the next. Browne (1995, p. 385) and Clark (1984, p. 55) talk about a type of chaining practice that Darwin exhibits in following several print sources until his eventual finding of Malthus's (1798/1933) population essay. It was considered whether to include chaining as a DIB in this dissertation. However, submission deadlines necessitated a stopping point for this particular study and it was decided that the line of inquiry pursued in this study had not indicated specific instances of Darwin's chaining behavior from his own words and that that was an area that might be taken up at a later time. Future studies of Darwin's information behaviors may, in fact, add more broad categories and DIB subcategories. As precedent, it is noted that Ellis et al. (1993), which provided some foundation for this study, added two additional information seeking categories from Ellis's (1989) earlier solo study. Similarly, further studies of Darwin's information behaviors may support the conflation of some DIB subcategories. Because an objective of this dissertation was to inventory Darwin's information behaviors, it was decided to identify as many of Darwin's information behaviors as possible that could be derived from his own words and descriptions in his letters and writings. Future research may indicate that certain categories and subcategories of Darwin information behaviors should be revised. As precedent again, Darwin repeatedly added to and revised *Origin*, culminating with a sixth edition, as new insights and information came to light, which Quammen (2006) describes in interesting detail. The same may or may not prove necessary or advisable, as well, as identification, inventorying, and enhanced understanding of Darwin's information behaviors develops and inevitably evolves.

This dissertation employed five broad context information behavior (BCIB) categories to generally group and describe Darwin's information behaviors. However, through future research other broad contexts might be developed for studying, grouping, and describing Darwin's information behaviors. As was noted regarding the DIBs discussed in this section, any of the five broad contexts, such as Darwin's information seeking or information communicating, could merit a study of its own, as well.

It might be useful to examine Darwin's information behaviors in terms of active and passive behaviors. Active information behaviors are those in which an affirmative act is performed in furtherance of a predetermined goal. Examples of active information behaviors are labeling, cataloguing, indexing, etc. Passive information behaviors are not conducted with a specific or preconceived action or goal. Browsing and reading are good examples of passive information behaviors. Such behaviors may yield information but do not require specific intent or an anticipated outcome before the activity is commenced or during its performance. Modeling Darwin's active and passive information behaviors might be beneficial for discovering patterns in his information behaviors and processes.

Refining the models which were created and presented in this dissertation and creating new models to depict Darwin's information behaviors are potential areas for additional research and development. Such models may be beneficial in continuing the efforts to deepen understanding of Darwin's information process behaviors and the information contexts within which he operated. Finally, this may promote a greater sense of his complex and multi-faceted relationship with information and underscore his relevance to LIS history and research.

Another area of inquiry is to look at the role of information technology in relation to Darwin and his work. What technologies did Darwin employ in seeking, organizing, managing, communicating, and using information? Did Darwin's information behaviors change as new technologies became available throughout the decades of the 1800's in which he lived? Was Darwin able to utilize new technologies in his work? For example, Darwin used the budding technology of photographs to analyze human faces in the 1860's and 1870's for his study of emotions. He published *Expression: The Expression of the Emotions in Man and Animals* (1872), based on that research, which incorporated photographs.

This dissertation identified many instances that depicted Darwin's prowess in information seeking, organizing, managing, etc. It also described several examples of information-related mistakes or omissions which Darwin made. One such example was detailed in discussing the DIB of labeling above, in which Darwin failed to label the islands of origin for the finches that he had collected on the Galapagos. It might be informative to study this finch example in more depth, and other examples like this, which expose Darwin's information behavioral errors or misjudgments, to determine what, if anything, he might have learned from these experiences and how these teachable moments may have potentially shaped and informed his development.

Finally, regarding Darwin's learning, questions arise as to how he learned and/or developed certain behaviors and practices, including the use of portfolios to arrange his magazines, articles, pamphlets, etc., his book arrangement schemes and other filing systems, such as the creation of a numbering system for print materials around 1850, as noted by the late Darwin scholar Peter Vorzimmer (1964), and his ability to index, abstract, and annotate his own print materials and those of others. Were practices like these typical of scientists and researchers of his time or atypical? This dissertation notes that some information behavior-related practices, such as collecting, recording, labeling, etc., were exhibited by other scientists of Darwin's era. But how common were they, were more involved or complex information behavior-related activities such as classifying, cataloguing, and abstracting prevalent, and if more complex as well as simpler information behavior practices were customary among scientists, where and when were these information skill sets taught and in what ways were they learned and honed? Were these information literacy skills taught and acquired at boarding schools, such as Darwin's Shrewsbury School, or at universities like Edinburgh and Cambridge? The historical record establishes that the professor as mentor and student as apprentice relationship was endemic to British Victorian era higher education. In point of fact, an 1845 letter by Darwin to Joseph Dalton Hooker imparts that Cambridge University geology professor John Stevens Henslow was "to me & others, a most kind friend and guide" (DCOD, Letter 826, [10 February 1845]). Clearly, as this dissertation describes, Darwin enjoyed and benefitted from the tutelage and privileges flowing from his relationships with mentors, such as John Stevens Henslow and Charles Lyell. In the cases of Henslow and Lyell, both men provided him with advice and feedback on how to collect, record, observe, preserve, publish, and more. It would, therefore, be informative to further study the roles of Darwin's mentors in his life, in order to more definitively understand their impact on his information-related activities. In doing so, a clearer picture may potentially emerge as to the intrinsic nature of Darwin's information behaviors and the environmental influences that shaped them.

APPENDIX A

TIMELINE OF CHARLES ROBERT DARWIN'S 1809-1882 LIFE

A timeline of significant events in the life of Charles Robert Darwin is provided. It incorporates many information-relevant happenings in Darwin's life that are discussed in this dissertation. This timeline was composed with reference to a Darwin chronology in Darwin (2003) and the CWCDO's Darwin timeline, retrieved April 27, 2007 from http://darwin-online.org.uk/timeline.html. The Darwin (2003) chronology depicts Darwin's life events in a table format with informative side-by-side literary contextual and historical events (pp. xxxiv-xlv). However, its references for Darwin are brief and some years are unrepresented. In contrast, the CWCDO's timeline covers most years of Darwin's life and has more detailed information for each entry, but literary and historical contexts, like those in Darwin (2003), are not included.

1809 Born February 12 (exact month, day, and year as Abraham Lincoln's birth) in Shrewsbury, Shropshire; son of Dr. Robert Waring Darwin and Susannah Wedgwood; grandson of Erasmus Darwin, doctor and author of scientific work *Zoonomia*, which discussed an early evolutionary theory similar to Jean Baptiste de Lamarck, and Josiah Wedgwood, potter and prominent slavery abolitionist (both grandfathers were members of the Lunar Society, an Industrial Revolution scientific discussion group)

1817 Mother, Susannah Wedgwood, dies

1818 Sent to boarding school, Shrewsbury School, and stays for 7 years

1825 Enrolls at Edinburgh University to study medicine

1828 Abandons medical study and enters Christ's College, Cambridge to become clergyman; Attends John Stevens Henslow's botany lectures

1831 Successfully completes BA examinations without honors; Joins Cambridge geology professor Adam Sedgwick on field trip to Wales; Embarks December 27 on 5-year *Beagle* voyage as ship's naturalist, following recommendation of Cambridge mentor, John Stevens Henslow; Collects specimens in South America, Galapagos, Tahiti, New Zealand, Australia, Africa, etc. throughout voyage and transmits many back to England for storage and later description and publication; Reads and references ship's library arranged in his shared poop cabin through duration of voyage

1832 Begins to record *Beagle* voyage observations in field notebooks; Reads volume 1 of geologist Charles Lyell's *Principles of Geology*, credited by Darwin as profoundly influencing his scientific thinking; Requests volumes 2 and 3 of Lyell's *Principles*, which are procured in England and sent to him by ship for pick-up in South America

1836 *Beagle* arrives back in England October 2; Pursues publication of scientific papers

1837 Presents papers at the Geological Society of London; Commissions subject specialists to identify and describe *Beagle* specimens; Begins friendship and scientific peer relationship with geologist Charles Lyell; Looks at his notebook on "transmutation of species"

1838 Joins Athenaeum Club in London (Charles Dickens joins at same time) and begins networking with other scientists, such as Charles Babbage; Reads Malthus's (1798/1933) population essay, found through reading and following of other references

1839 Marries cousin Emma Wedgwood on January 29; Publishes *Journal of Researches (*later renamed *The Voyage of the Beagle)*; Becomes a Fellow of the Royal Society via election; Emma bears first child, William; Solicits answers to Questions about the breeding of animals from farmers and landowners

1842 Moves from London to Down House, Kent, where he lives with wife and children until death in 1882; Sketches theory of "descent with modification"—first writing, though unpublished, on evolutionary theory

1843 Begins friendship and scientific peer relationship with botanist Joseph Dalton Hooker, just-returned from Antarctic survey expedition

1844 Further develops 1842 sketch into an essay of evolutionary theory by natural selection; Provides wife Emma with written instructions for publication of this essay, in event of his death

1846 Begins 8-year taxonomy work on description and classification of barnacles and publishes volumes on barnacles through this period

1848 Father, Dr. Robert Waring Darwin, dies

1851 Death of 10-year old daughter Annie impacts religious beliefs

1854 Publishes last books on barnacles and commences study of species

1856 Charles Lyell encourages writing of evolutionary views for book publication

1857 Sends letter to Harvard University botanist Asa Gray, describing his evolutionary theory by natural selection, and keeps draft copy of letter

1858 Continues to evaluate and compile his collected facts and information, telling cousin William Darwin Fox in February 28 letter that he is "*over* facted"; Receives unexpected letter June 18 from Alfred Russel Wallace, who is collecting specimens in Malay Archipelago, and accompanying essay which is strikingly similar to Darwin's evolutionary theory by natural selection; Infant Charles Darwin dies June 28 of scarlet fever; Retrieves preserved and filed papers to evince priority for evolutionary ideas: Hooker and Lyell present (1) Darwin's 1844 sketch, (2) draft copy of Darwin's 1857 letter to Asa Gray, and (3) Wallace's 1858 essay at Linnean Society of London on July 1, with neither Darwin nor Wallace in attendance; Darwin's and Wallace's respective July 1 Linnean Society-presented papers are subsequently published in *Journal of the Proceedings of the Linnean Society of London*; Darwin commences work toward publishing his evolutionary ideas as an "abstract"

1859 *The Origin of Species* is published November 24 by John Murray of London

1860 2nd edition of *Origin* is published

1861 3rd edition of *Origin* is published

1864 Receives Copley Medal from the Royal Society of London, its most prestigious scientific award

1866 4th edition of *Origin* is published

1867 Writes letter (believed to be written to Sir James Paget, who was appointed surgeon extraordinary to Queen Victoria in 1858) of which extant fragment "I am greedy for facts" is housed at the American Philosophical Society in Philadelphia, PA.

1868 *The Variation of Animals and Plants Under Domestication* is published

1869 5th edition of *Origin* is published

1871 *The Descent of Man, and Selection in Relation to Sex* is published

1872 6th edition of *Origin* is published; Uses photographs to study facial expressions and publishes *The Expression of the Emotions in Man and Animals*

1876 Composes an autobiography for his children and future grandchildren

1877 Receives honorary degree from Cambridge; Writes and publishes *A biographical sketch of an Infant*, based on 1839-1841 diary notes recorded about his first child, William Darwin

1882 Dies April 19 at age seventy-three; Buried in Westminster Abbey April 26

APPENDIX B

DARWIN-RELATED BOOKS

Armstrong, P. (1985). *Charles Darwin in Western Australia: A young scientist's perception of an environment*. Nedlands, WA: University of Western Australia Press.

Barlow, N. (Ed). (1958). *The autobiography of Charles Darwin: 1809-1882*. New York: W.W. Norton & Company, Inc.

Barrett, P., et al. (Eds.). (1987). *Charles Darwin's notebooks, 1836-1844*. Ithaca, New York: Cornell University Press.

Bowler, P. (2003). *Evolution: The history of an idea* (3rd ed.). Los Angeles: University of California Press.

Browne, J. (1995). *Charles Darwin: Voyaging*. Princeton, NJ: Princeton University Press.

Browne, J. (2002). *Charles Darwin: The power of place*. Princeton, NJ: Princeton University Press.

Burkhardt, F. (Ed.). (1998). *Charles Darwin's letters: A selection, 1825-1859*. New York: Cambridge University Press.

Burkhardt, F., & Smith, S. (Eds.). (1985). *A calendar of the correspondence of Charles Darwin: 1821-1882*. New York: Garland Pub.

Burkhardt, F., & Smith, S. (Eds.). (1985-2004). *The correspondence of Charles Darwin: Volumes 1-15, 1821-1867*. New York: Cambridge University Press.

Cambridge University Library. (1960). *Handlist of Darwin papers at the University Library, Cambridge*. Cambridge: Cambridge University Press.

Clark, R. (1984). *The survival of Charles Darwin: A biography of a man and an idea*. New York: Random House.

Darwin, C. (1906). *The voyage of the Beagle*. New York: Random House, Inc.

Darwin, C. (1923). *The origin of species*. New York: Random House, Inc.

Darwin, C. (2003). *The origin of species and the voyage of the Beagle: with an introduction by Richard Dawkins*. New York: Alfred A. Knopf.

Darwin, F., & Seward, A. (Eds.). (1903). *More letters of Charles Darwin, a record of his work in a series of hitherto unpublished letters*. New York: D. Appleton & Company.

Darwin, F. (Ed.). (1958). *Selected letters on evolution and origin of species: With an autobiographical chapter*. Mineola, NY: Dover Publications, Inc.

Darwin, F. (Ed.). (1959). *The life and letters of Charles Darwin*. New York: Basic Books, Inc.

Dawkins, R. (2003). *A devil's chaplain: Reflections on hope, lies, science, and love*. New York: Houghton Mifflin Company.

Dennett, D. (1995). *Darwin's dangerous idea: Evolution and the meanings of life*. New York: Simon & Schuster.

Desmond, A., & Moore, J. (1991). *Darwin: The life of a tormented evolutionist*. New York: W.W. Norton & Company, Inc.

Di Gregorio, M. (Ed.). (1990). *Charles Darwin's marginalia*. New York: Garland Publishing.

Eldredge, N. (2005). *Darwin: Discovering the tree of life*. New York: W.W. Norton & Company, Inc.

Fichman, M. (2002). *Evolutionary theory and Victorian culture*. Amherst, NY: Humanity Books.

Freeman, R. (1977). *The works of Charles Darwin: An annotated bibliographical handlist*. Hamden, CT: Archon Books.

Freeman, S., & Herron, J. (2004). *Evolutionary analysis, Third Edition*. Upper Saddle River, NJ: Pearson Prentice Hall.

Glass, B., Temkin, O., & Straus, W., Jr. (Eds.). (1959). *Forerunners of Darwin*. Baltimore: Johns Hopkins Press.

Gould, S. (2002). *The structure of evolutionary theory*. Cambridge, MA: Belknap Press of Harvard University Press.

Gruber, H. (1981) *Darwin on man: A psychological study of scientific creativity*. Chicago: University of Chicago Press.

Herbert, S. (Ed). (1980). *The red notebook of Charles Darwin*. Ithaca, New York: Cornell University Press.

Herbert, S. (2005). *Charles Darwin, Geologist*. Ithaca, NY: Cornell University Press.

Keynes, R. (Ed.). (1979). *The Beagle record: Selections from the original pictorial records and written accounts of the voyage of H.M.S. Beagle*. New York: Cambridge University Press.

Keynes, R. (Ed.). (1988). *Charles Darwin's Beagle diary*. New York: Cambridge University Press.

Keynes, R. (Ed.). (2000). *Charles Darwin's zoology notes & specimen lists from H.M.S. Beagle*. New York: Cambridge University Press.

Keynes, R. (2003). *Fossils, finches and fuegians: Darwin's adventures and discoveries on the Beagle*. New York: Oxford University Press.

Larson, E. (2001). *Evolution's workshop: God and science on the Galapagos Islands*. New York: Basic Books.

Manier, E. (1978). *The young Darwin and his cultural circle: A study of influences which helped shape the language and logic of the first drafts of the theory of natural selection*. Dordrecht: Reidel.

Marshall, A. (1970). *Darwin and Huxley in Australia*. Sydney: Hodder & Stoughton Ltd.

Mills, C. (2004). *The theory of evolution: What it is, where it came from, and why it works*. Hoboken, NJ: John Wiley & Sons, Inc.

Moorehead, A. (1969). *Darwin and the Beagle*. London: Harper & Row Publishers. Inc.

Nicholas, F., & Nicholas, J. (1989). *Charles Darwin in Australia*. Sydney: Cambridge University Press.

Nichols, P. (2003). *Evolution's captain: The dark fate of the man who sailed Charles Darwin around the world*. New York: HarperCollins Publisher, Inc.

Raby, P. (1996). *Bright paradise: Victorian scientific travelers*. Princeton, NJ: Princeton University Press.

Ross, R., & Allmon, W. (Eds.). (1990). *Causes of evolution: A paleontological perspective*. Chicago: University of Chicago Press.

Thomson, K.S. (1995). *H.M.S. Beagle, The story of Darwin's ship*. New York: W.W. Norton.

Tort, P. (2000). *Darwin and the science of evolution* (P. Bahn, Trans.). New York: Harry N. Abrams, Inc

Vorzimmer, P. (1970). *Charles Darwin: The years of controversy, The origin of species and its critics 1859-1882*. Philadelphia: Temple University Press.

Watson, J. (Ed.). (2005). *Darwin: The indelible stamp*. Philadelphia: Running Press Book Publishers.

Weinshank, D., et al. (Eds.). (1990). *A concordance to Charles Darwin's notebooks, 1836-1844*. Ithaca, NY: Cornell University Press.

APPENDIX C

DARWIN-RELATED ARTICLES

Butcher, B. (1989). "Adding stones to the great pile"? Charles Darwin's use of Australian resources, 1837-1882. *Historical Records of Australian Science, 8* (1), 1-14.

Keynes, R. (1997). Steps on the path to the Origin of Species. *Journal of Theoretical Biology*. 187, pp. 461-471.

Keynes, R. (2003). From bryozoans to tsunami: Charles Darwin's findings on the *Beagle*. *Proceedings of the American Philosophical Society 2003, 147*(2), 103-127.

Kohn, D., Smith, S., & Stauffer, R. (1982). New light on the foundations of the *Origin of Species*: A reconstruction of the archival record. *Journal of the History of Biology, 15*(3), 419-442.

Kottler, M. (1978). Charles Darwin's biological species concept and theory of geographic speciation: The transmutation notebooks. *Annals of Science, 35* (3), 275-298.

Lennox, J. (2005). Darwin's methodological evolution. *Journal of the History of Biology, 38*, 85-99.

Oliveira, J., & Barabasi, A. (2005). Human dynamics: Darwin and Einstein correspondence patterns. *Nature, 437*(7063), 1251.

Richardson, A. (1981). Biogeography and the genesis of Darwin's ideas of transmutation. *Journal of the History of Biology, 14*(1), 1-41.

Schweber, S. (1977). The origin of the *origin* revisited. *Journal of the History of Biology, 10*(2), 229-316.

Sheets-Pyenson, S. (1981). Darwin's data: His reading of natural history journals, 1837-1842. *Journal of the History of Biology, 14*(2), 231-248.

Shera, J. (1964). Darwin, Bacon, and research in librarianship. *Library Trends, 13*(1), 141-149.

Storch, D., Marquet, A., & Gaston, K. (2005). Untangling an entangled bank. *Science*, *307*(5710), 684-686.

Veak, T. (2003). Exploring Darwin's correspondence: Some important but lesser known correspondents and projects. *Archives of Natural History, 30*, 118-138.

Vorzimmer, P. (1977). The Darwin reading notebooks (1838-1860). *Journal of the History of Biology, 10*(1), 107-153.

APPENDIX D

DARWIN-RELATED DISSERTATIONS AND THESES

Bell, J. (1989). Charles Darwin as a laboratory director (Doctoral dissertation, University of California, Los Angeles, 1989). *Dissertation Abstracts International, 50,* (8), 2626.

Donnellan, L. (1986). The making of a field naturalist: Case study of professional socialization (Doctoral dissertation, Rensselaer Polytechnic Institute, 1986). *Dissertation Abstracts International, 47* (6), 2322.

Gale, B. (1980). After Malthus: Darwin working on his species theory, 1838-1859 (Doctoral dissertation, University of Chicago, 1980). *Dissertation Abstracts International,* 41 (3), 1192.

Gitelman, L. (1991). The world recounted; science and narrative in early nineteenth century exploration accounts (Doctoral dissertation, Columbia University, 1991). *Dissertation Abstracts International, 52* (8), 2931.

Karanikas, M. (1992). Metaphor and invention: Case studies in the writing of biology (Doctoral dissertation, University of Illinois at Chicago, 1992). *Dissertation Abstracts International, 53* (12), 4315.

Kaye, J. (1996). Charles Darwin's scientific development: A Levinsonian study of early and middle adulthood (Doctoral dissertation, The Wright Institute, 1996). *Dissertation Abstracts International, 57* (7), 4746.

Keegan, R. (1985). The development of Charles Darwin's thinking on psychology (creativity, cognition, evolution) (Doctoral dissertation, Rutgers The State University of New Jersey-Newark, 1985). *Dissertation Abstracts International, 46* (6), 2049.

McNeil, M. (1980). A contextual study of Erasmus Darwin (Doctoral dissertation, University of Cambridge, 1980).

Vorzimmer, P. (1964). The development of Darwin's evolutionary thought after 1859 (Ph.D. thesis, 2 vols., University of Cambridge, 1964).

APPENDIX E

DARWIN-RELATED ELECTRONIC RESOURCES

American Museum of Natural History. *Darwin exhibition*. Retrieved November 11, 2005, from American Museum of Natural History, Darwin exhibition, New York: http://www.amnh.org/exhibitions/darwin/?src=h_h

American Philosophical Society Library. *Darwin collection*. Retrieved March 16, 2006, from American Philosophical Society Library, Philadelphia, PA: http://www.amphilsoc.org/library/mole/d.htm

Blinderman, C., & Joyce, D. *The Huxley file*. Retrieved March 16, 2006, from Clark University, Worcester, MA: http://aleph0.clarku.edu/huxley/

Cambridge University Library. *Darwin correspondence project*. Retrieved November 11, 2005, from Cambridge University Library: http://www.lib.cam.ac.uk/Departments/Darwin/

Cambridge University Library. *Darwin correspondence project: Extended bibliography*. Retrieved January 7, 2006, from Cambridge University Library: http://darwin.lib.cam.ac.uk/bib_all.html

English Heritage. *The home of Charles Darwin, Down House*. Retrieved November 11, 2005, from English Heritage: http://www.english-heritage.org.uk/server.php?show=ConProperty.102

Lennox, J. (2004). Darwinism [Electronic version]. *Stanford encyclopedia of philosophy*. Retrieved August 10, 2005, from http://plato.stanford.edu/archives/fall2004/entries/darwinism.

Natural History Museum. *Darwin Centre*. Retrieved November 11, 2005, from Natural History Museum, Darwin Centre, London, UK: http://www.nhm.ac.uk/visit-us/galleries/darwin-centre/

Royal Society, Library and Archives. Retrieved March 16, 2006, from Royal Society, Library and Archives, London, UK: http://www.royalsoc.ac.uk/page.asp?id=1646

van Wyhe, J. (Ed.). (2005). *The writings of Charles Darwin on the web*. Retrieved January 7, 2006, from http://pages.britishlibrary.net/charles.darwin/

van Wyhe, J. (2006). *The complete work of Charles Darwin online*. Retrieved March 16, 2005, from University of Cambridge, Cambridge, UK: http://darwin-online.org.uk/

Weitzel, V. (Ed.). (1995). T*he journal of Syms Covington: Assistant to Charles Darwin, Esq. on the second voyage of the HMS Beagle December 1831-September 1836*. Retrieved February 10, 2005, from University of Melbourne, Australian Science Archives Project: http://www.asap.unimelb.edu.au/bsparcs/covingto/contents.htm

BIBLIOGRAPHY

Allison, G.T., & Zelikow, P. (1999). *Essence of decision: Explaining the Cuban missile crisis* (2nd ed.). New York: Addison Wesley Longman.

Armstrong, P. (1985). *Charles Darwin in Western Australia: A young scientist's perception of an environment*. Nedlands, Western Australia: University of Western Australia Press.

Avery, J. (2003). *Information theory and evolution*. River Edge, NJ: World Scientific Publishing Co.

Baker, L. (2004). Information needs at the end of life: A content analysis of one person's story. *Journal of the Medical Library Association, 92*(1), 78-82.

Barkow, J. Cosmides, L. and Tooby, J. (1992). *The adapted mind: Evolutionary psychology and the generation of culture*. New York: Oxford University Press.

Barlow, N. (Ed.). (1958). *The autobiography of Charles Darwin: 1809-1882*. New York: W.W. Norton, Inc.

Barrett, P., et al. (Eds.). *Charles Darwin's notebooks, 1836-1844*. Ithaca, NY: Cornell University Press.

Bastian, J. (1999). Defining custody: The impact of archival custody on the relationship between communities and their historical records in the information age—A case study of the U.S. Virgin Islands (Doctoral dissertation, University of Pittsburgh, 1999). *Dissertation Abstracts International, 61* (1), 14.

Bates, M. (2005). Information and knowledge: An evolutionary framework for information science. *Information Research*, 10(4), 1-35.

Bell, J. (1989). Charles Darwin as a laboratory director (Doctoral dissertation, University of California, Los Angeles, 1989). *Dissertation Abstracts International, 50,* 8.

Berg, B. (2004). *Qualitative research methods for the social sciences*. Boston: Pearson/Allyn and Bacon.

Bernard, H.R. (2002). *Research methods in anthropology*. Walnut Creek, CA: Altamira Press.

Bettina, K. (1994). Der quipu—Informationsvermittlung im alten Peru. [The quipus—Information transmission in old Peru]. *Biblos, 43*(3-4), 179-182.

Brewer, J., & Hunter, A. (1989). *Multimethod research: A synthesis of styles*. Newbury Park, CA: Sage Publications.

Browne, J. (1995). *Charles Darwin: Voyaging*. Princeton, NJ: Princeton University Press.

Browne, J. (2002). *Charles Darwin: The power of place*. Princeton, NJ: Princeton University Press.

Buchwald, C. (2000). A case study of Canada's coalition for public information in the information highway policy-making process. *Library & Information Science Research, 22*(2), 123-144.

Burkhardt, F., & Smith, S. (Eds.). (1985-2005). *The correspondence of Charles Darwin: Volumes 1-15, 1821-1867*. New York: Cambridge University Press.

Butcher, B. (1989). "Adding stones to the great pile"? Charles Darwin's use of Australian resources, 1837-1882. *Historical Records of Australian Science, 8*(1), 1-14.

The calendar of the correspondence of Charles Darwin. Retrieved April 7, 2007, from http://darwin.lib.cam.ac.uk/.

Cambridge University Library. (1960). *Handlist of Darwin papers at the University Library, Cambridge*. Cambridge: Cambridge University Press.

Campbell, D., & Fiske, D. (1959). Convergent and discriminant validation by the multitrait-multimethod Matrix. *Psychological Bulletin, 56*(2), 81-105.

Carroll, R. (2000). Towards a new evolutionary synthesis. *Trends in Ecology & Evolution, 15*(1), 27-32.

Case, D. (2002). *Looking for information: A survey of research on information seeking, needs, and behavior*. San Diego: Academic Press.

Chatman, E. (1992). *The information world of retired women*. Westport, CT: Greenwood Press.

Chatman, E. (1996). The impoverished life-world of outsiders. *Journal of the American Society for Information Science, 47*(3), 193-206.

Chatman, E. (1999). A theory of life in the round. *Journal of the American Society for Information Science, 50*(3), 207-217.

Christensen, A. (2002). The Incan quipus. *Synthese, 133*, 159-172.

Clark, R. (1984). *The survival of Charles Darwin: a biography of a man and an idea*. New York: Random House.

Cobbledick, S. (1996). The information-seeking behavior of artists: Exploratory interviews. *Library Quarterly, 66*(4), 343-372.

Cole, C. and Leide, J. (2006). Human information organizing behavior. In: A. Spink & C. Cole (Eds.), *New Directions in Human Information Behavior* (pp. 171-202). Dordrecht, The Netherlands: Springer.

Cronin, B. (1982). Invisible colleges and information transfer: A review and commentary with particular reference to the social sciences. *Journal of Documentation, 38*(3), 212-236.

The Darwin Correspondence Online Database (DCOD), Cambridge University, UK. Retrieved April 7, 2007, from http://www.lib.cam.ac.uk/Departments/Darwin/index.html.

Darwin, C. (1839) *Journal of researches*. London: Henry Colburn

Darwin, C. (1859/1923). *The origin of species*. New York: Random House, Inc.

Darwin, C. (1872). *Expression: The expression of the emotions in man and animals.* London: John Murray.

Darwin, C. (2003). *The origin of species and the voyage of the Beagle*. New York: Alfred A. Knopf

Darwin, F. (Ed.). (1898). *The life and letters of Charles Darwin: Including an autobiographical chapter.* New York: D. Appleton and Company.

Dawkins, R. (2003). *A devil's chaplain: Reflections on hope, lies, science, and love*. New York: Houghton Mifflin Company.

Denzin, N. (1978). *The research act: A theoretical introduction to sociological methods* (2nd ed.). New York: McGraw-Hill.

Denzin, N., & Lincoln, Y. (2000). *Handbook of qualitative research (2d ed.)*. Thousand Oaks, CA: Sage Publications.

Dervin, B. (1992). From the mind's eye of the user: The sense-making qualitative-quantitative methodology. In J. Glazier & R. Powell (Eds.), *Qualitative Research in Information Management* (pp. 61-84). Englewood, CO: Libraries Unlimited.

Desmond, A., & Moore, J. (1991). *Darwin: The life of a tormented evolutionist*. New York: W.W. Norton & Company, Inc.

Di Gregorio, M. (Ed.). (1990). *Charles Darwin's marginalia*. New York: Garland Publishing.

Eldredge, N. (2005). *Darwin: Discovering the tree of life*. New York: W.W. Norton & Company.

Ellis, D. (1989). A behavioral approach to information retrieval system design. *Journal of Documentation, 45*(3), 171-212.

Ellis, D. (1993). Modeling the information-seeking patterns of academic researchers: A grounded theory approach. *Library Quarterly, 63*(4), 469-486.

Ellis, D., Cox, D., & Hall, K. (1993). A comparison of the information-seeking patterns of researchers in the physical and social sciences. *Journal of Documentation, 49*(5), 356-360.

Fisher, K., Durrance, J., & Hinton, M. (2004). Information grounds and the use of need-based service by immigrants in Queens, New York: A context-based, outcome evaluation approach. *Journal of the American Society for Information Science and Technology, 55*(8), 754-766.

Folster, M. (1989). A study of the use of information sources by social science researchers. *Journal of Academic Librarianship, 15*, 7-11.

Gale, B. (1980). After Malthus: Darwin working on his species theory, 1838-1859 (Doctoral dissertation, University of Chicago, 1980). *Dissertation Abstracts International,* 41/03, 1192.

Gay, L., & Airasian, P. (2003). *Educational research: Competencies for analysis and applications*. Upper Saddle River, NJ: Pearson Education, Inc.

Ghauri, P., & Gronhaug, K. (2002). *Research methods in business studies: A practical guide*. Harlow, England: Pearson Education.

Gilgun, J. (1994). A case for case studies in social work research. *Social Work, 39*, 371-380.

Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Chicago: Aldine.

Gopnik, A. (2006). Rewriting nature. *The New Yorker*, 82(34), 52-59.

Gorman, P. (1995). Information needs of physicians. *Journal of the American Society for Information Science, 46*(10), 729-736.

Gould, C., & Handler, M. (1989). *Information needs in the social sciences*. Mountain View, CA: Research Libraries Group.

Haddon, A. (1895). *Evolution in art: As illustrated by the life-histories of designs*. New York: Charles Scribner's Sons.

Hargittai, E., & Hinnant, A. (2006). Toward a social framework for information seeking. In: A. Spink & C. Cole (Eds.), *New directions in human information behavior* (pp. 55-70). Dordrecht, The Netherlands: Springer.

Haupt, L. (2006) *Pilgrim on the great bird continent: The importance of everything and other lessons from Darwin's lost notebooks*. New York: Little, Brown and Company.

Haycock, D. (2004). 'The long-lost truth': Sir Isaac Newton and the Newtonian pursuit of ancient knowledge. *Studies in History and Philosophy of Science Part A, 35*(3), 605-623.

Herbert, S. (1980). *The red notebook of Charles Darwin*. Ithaca, NY: Cornell University Press.

Herbert, S. (2005). *Charles Darwin, Geologist*. Ithaca, NY: Cornell University Press.

Howell, M., & Prevenier, W. (2001). *From reliable sources: An introduction to historical methods.* Ithaca, NY: Cornell University Press.

Huberman, A., & Miles, M. (2002). *The qualitative researcher's companion*. Thousand Oaks, CA: Sage Publications.

Isaacson, W. (2007). *Einstein: His life and universe*. New York: Simon & Schuster.

Kaplan, S. (1992). Environmental preference in a knowledge-seeking, knowledge-using organism. In: J. Barkow, L. Cosmides, & J. Tooby, *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 581-598). New York: Oxford University Press.

Karanikas, M. (1992). Metaphor and invention: Case studies in the writing of biology. (Doctoral dissertation, University of Illinois at Chicago, 1992). *Dissertation Abstracts International, 53/12*, 4315.

Kaye, J. (1996). Charles Darwin's scientific development: A Levinsonian study of early and middle adulthood (Doctoral dissertation, The Wright Institute, 1996). *Dissertation Abstracts International, 57/07,* 4746.

Keegan, R. (1985). The development of Charles Darwin's thinking on psychology (creativity, cognition, evolution) (Doctoral dissertation, Rutgers The State University of New Jersey-Newark, 1985). *Dissertation Abstracts International, 46/06,* 2049.

Keynes, R. (2003a). *Fossils, finches and Fuegians: Darwin's adventures and discoveries on the Beagle*. Oxford, UK: Oxford University Press.

Keynes, R. (2003b). From bryozoans to tsunami: Charles Darwin's findings on the *Beagle*. *Proceedings of the American Philosophical Society 2003, 147*(2), 103-127.

Kohn, D., Smith, S., & Stauffer, R. (1982). New light on the foundations of the *Origin of Species*: A reconstruction of the archival record. *Journal of the History of Biology, 15*(3), 419-442.

Kottler, M. (1978). Charles Darwin's biological species concept and theory of geographic speciation: The transmutation notebooks. *Annals of Science, 35*(3), 275-298.

Krathwohl, D. (1998). *Methods of educational and social science research: An integrated approach* (2d ed.). Long Grove: IL: Waveland Press.

Kraut, R., Egido, C., & Galegher, J. (1990). Patterns of contact and communication in scientific research collaboration. In J. Galegher, R. Kraut, & C. Egido (Eds.). *Intellectual teamwork: Social and technological foundations of cooperative work*. Hillsdale, NJ: Lawrence Erlbaum.

Kuhlthau, C.C. (1994). *Seeking meaning: A process approach to library and information services*. Norwood, NJ: Ablex Publishing.

Kuhlthau, C. (1999). The role of experience in the information search process of an early career information worker: Perceptions of uncertainty, complexity, construction, and sources. *Journal of the American Society for Information Science, 50*(5), 399-412.

Leakey, R. and Lewin, R. (1977). *Origins: What new discoveries reveal about the emergence of our species and its possible future*. New York: E.P. Dutton.

Lennox, J. (2005). Darwin's methodological evolution. *Journal of the History of Biology, 38*, 85-99.

Lyell, C. (1830-1833). *Principles of geology, being an attempt to explain the former changes of the earth's surface, by reference to causes now in operation*. 3 vols. London: John Murray.

Madden, A. (2004). Evolution and information. *Journal of Documentation, 60*(1), 9-23.

Madden, A., Bryson, J., & Palimi, J. (2006). Information seeking in pre-literate societies. In A. Spink & C. Cole (Eds.), *New directions in human information behavior* (pp. 33-53). Dordrecht, The Netherlands: Springer.

Malthus, T. (1798/1933). *An essay on population*. London: Dent.

Malthus, T. (1826). *An essay on the principle of population; or, a view of its past and present effects on human happiness; with an inquiry into our prospects respecting the future removal or mitigation of the evils which it occasions*. 6th edition. 2 vols. London: John Murray.

McDowell, W. (2002). *Historical research: A guide*. Harlow, England: Pearson Education Limited.

McKitterick, D. (1986) *Cambridge university library, a history: The eighteenth and nineteenth centuries*. New York: Cambridge University Press.

Meho, L.., & Tibbo, H. (2003) Modeling the information-seeking behavior of social scientists: Ellis's study revisited. *Journal of the American Society for Information Science and Technology 54*(6), 570-587.

Miles, M., & Huberman, N. (1994). *Qualitative data analysis* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Mithen, S. (1988). Looking and learning: Upper Palaeolithic art and information gathering. *World Archaeology, 19*, 297-327.

Mithen, S. (1996). *The prehistory of the mind: The cognitive origins of art and science*. London: Thames & Hudson.

The new Oxford American dictionary. (2001). Oxford, UK: Oxford University Press.

Nicholas, F., & Nicholas, J. (2002). *Charles Darwin in Australia*. Cambridge, UK : Cambridge University Press.

Ouzman, S. Tacon, P. Mulvaney, K. and Fullagar, R. (2002). Extraordinary engraved bird track from North Australia: Extinct fauna, dreaming being and/or aesthetic masterpiece. *Cambridge Archaeological Journal*, *12*(1), 103-112.

Pace, S. (2004). A grounded theory of the flow experiences of Web users. *International Journal of Human-Computer Studies, 60*(3), 327-363.

Patton, M. (2002). *Qualitative research & evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Payne, K. (1993). Information collection and transmission in classical Greece. *Libri*, 43(4), 271-288.

Pettigrew, K. (1999). Waiting for chirpody: Contextual results from an ethnographic study of the information behavior among attendees at community clinics. *Information Processing & Management, 35*(6), 801-817.

Pettigrew, K., Fidel, R., & Bruce, H. (2001). Conceptual frameworks in information behavior. In M.E. Williams, (Ed.), *Annual Review of Information Science & Technology, 35*, 43-78. Medford, NJ: ASIST and Information Today.

Pfeiffer, J. (1982). *The creative explosion: An inquiry into the origins of art and religion*. New York: Harper & Row.

Pirolli, P. & Card, S. (1999). Information foraging. *Psychological Review*, *106*, 643-675.

Poland, J. (1991). Informal communication among scientists and engineers. *Science and Technology Libraries*, 11(3), 61-73.

Quammen, D. (2006) *The reluctant Mr. Darwin: An intimate portrait of Charles Darwin and the making of his theory of evolution*. New York: W. W. Norton & Company, Inc.

Raby, P. (1996). *Bright paradise: Victorian scientific travellers*. Princeton, NJ: Princeton University Press.

Reed, G. (1995). The heelstone: The sundial sun god of Stonehenge. *Vistas in Astronomy, 39*(4), 713-714.

Rice, R., & Tarin, P. Staying informed: Scientific communication and the use of information sources within disciplines. In Bonzi, S. (Ed.). (1993). *American Society for Information Science, Proceedings of the 56th Annual Meeting*. Medford, NJ: Learned Information. 160-164.

Richardson, A. (1981). Biogeography and the genesis of Darwin's ideas of transmutation. *Journal of the History of Biology, 14*(1), 1-41.

Richmond, C. (1988). Hand and mouth: Information gathering and use in England in the later middle ages. *Journal of Historical Sociology, 1*, 233-252.

Robson, C. (2002). *Real world research: A resource for social scientists and practitioner-researchers* (2nd ed.). Malden, MA: Blackwell Publishers.

Russell, F. S. (1999). *Information gathering in classical Greece*. Ann Arbor, MI: University of Michigan Press.

Savolainen, R. (1995). Everyday life information seeking: Approaching information seeking in the context of way of life. *Library and Information Science Research*, *17*, 259-294.

Schweber, S. (1977). The origin of the *Origin* revisited. *Journal of the History of Biology, 10*(2), 229-316.

Settegast, M. (1986). *Plato prehistorian: 10,000 to 5,000 B.C. in myth and archaeology*. Cambridge, MA: Rotenberg Press.

Sheets-Pyenson, S. (1981). Darwin's data: His reading of natural journals, 1837-1842. *Journal of the History of Biology, 14*(2), 231-248.

Shera, J. (1964). Darwin, Bacon and research in librarianship. *Library Trends, 13*, 141-149.

Shera, J. (1965). *Libraries and the organization of knowledge*. Hamden, CT: Archon Books.

Sonnenwald, D., & Iivonen, M. (1999). An integrated human information behavior research framework for information studies. *Library & Information Science Research, 21*(4), 429-457.

Spink, A., & Cole, C. (2005). Human information behavior: Integrating diverse approaches and information use. *Journal of the American Society for Information Science and Technology, 57*(1), 25-35.

Spink, A., & Currier, J. (2006a). Emerging evolutionary approach to human information behavior. In A. Spink & C. Cole (Eds.), *New directions in human information behavior* (pp. 13-31). Dordrecht, The Netherlands: Springer.

Spink, A., & Currier, J. (2006b). Towards an evolutionary perspective for human information behavior: An exploratory study. *Journal of Documentation, 62*(2).

Stam, D. & Stam, D. (2002). Silent friends—Books and reading on polar expeditions. *Poles Apart–Poles On-Line: Proceedings of the 19th Polar Libraries Colloquy, 17-21 June 2002, Copenhagen*. Ed. Kirsten Caning and Vibeke Sloth Jakobsen. Copenhagen: Danish Polar Center, 2002. 113-19.

Stonier, T. (1997). *Information and meaning: An evolutionary perspective*. New York: Springer.

Thomas, N. (2003). *Cook: The extraordinary voyages of Captain James Cook*. New York: Walker & Company.

Tooby, J. and Cosmides, L. (1989). Evolutionary psychology and the generation of culture. Part I: Theoretical considerations. *Ethology and Sociobiology*, *10*, 29-49.

van Wyhe, J. (Ed.). (2006). *The Complete Work of Charles Darwin Online*. Retrieved April 7, 2006, from http://darwin-online.org.uk/.

Veak, T. (2003). Exploring Darwin's correspondence: Some important but lesser known correspondents and projects. *Archives of Natural History, 30*, 118-138.

Vorzimmer, P. (1964) *The development of Darwin's evolutionary thought after 1859*. 2 vols. (PhD thesis: University of Cambridge).

Vorzimmer, P. (1977). The Darwin reading notebooks (1838-1860). *Journal of the History of Biology, 10*(1), 107-153.

Wallace, D. (1997). The public's use of federal recordkeeping statutes to shape federal information policy: A study of the PROFS case (Doctoral dissertation, University of Pittsburgh, 1997). *Dissertation Abstracts International, 58* (10), 3765.

Watson-Boone, R. (1994). The information needs and habits of humanities scholars. *Research Quarterly, 34*(2), 203-216.

Weitzel, V. (Ed.). (1995). *The journal of Syms Covington: Assistant to Charles Darwin, Esq. on the second voyage of the HMS Beagle December 1831-September 1836*. Retrieved February 10, 2005, from University of Melbourne, Australian Science Archives Project: http://www.asap.unimelb.edu.au/bsparcs/covingto/contents.htm

Whyte, W. (1955). *Street corner society: The social structure of an Italian slum*. Chicago: University of Chicago Press. (Original work published 1943).

Wilford, J. (1992). The *mysterious history of Columbus*. New York: Vintage.

Wilson, T. (1999). Models in information behaviour research. *Journal of Documentation, 55*(3), 249-270.

Wilson, T. (2000). Human information behavior. *Informing Science*, *3*(2), 49-55.

Yin, R. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.